5-E-122

INSTRUCTION MANUAL

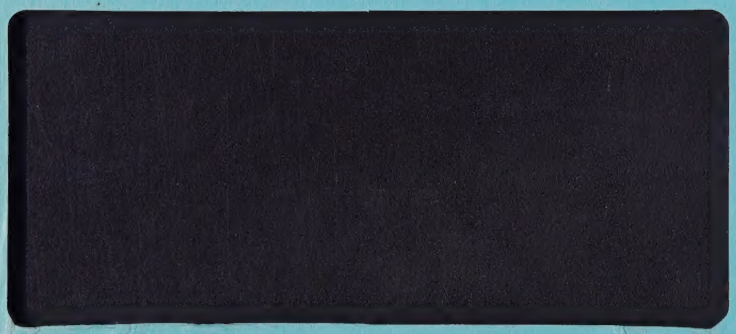
E 507

MODEL

TTS-4C
TRANSMISSION TEST SET

MP MASTER
MA32767

NORTHEAST ELECTRONICS CORPORATION
P.O. BOX 649 - CONCORD, N. H. 03301
AREA CODE 603 224-7466



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ISSUE 2
MAR 1973

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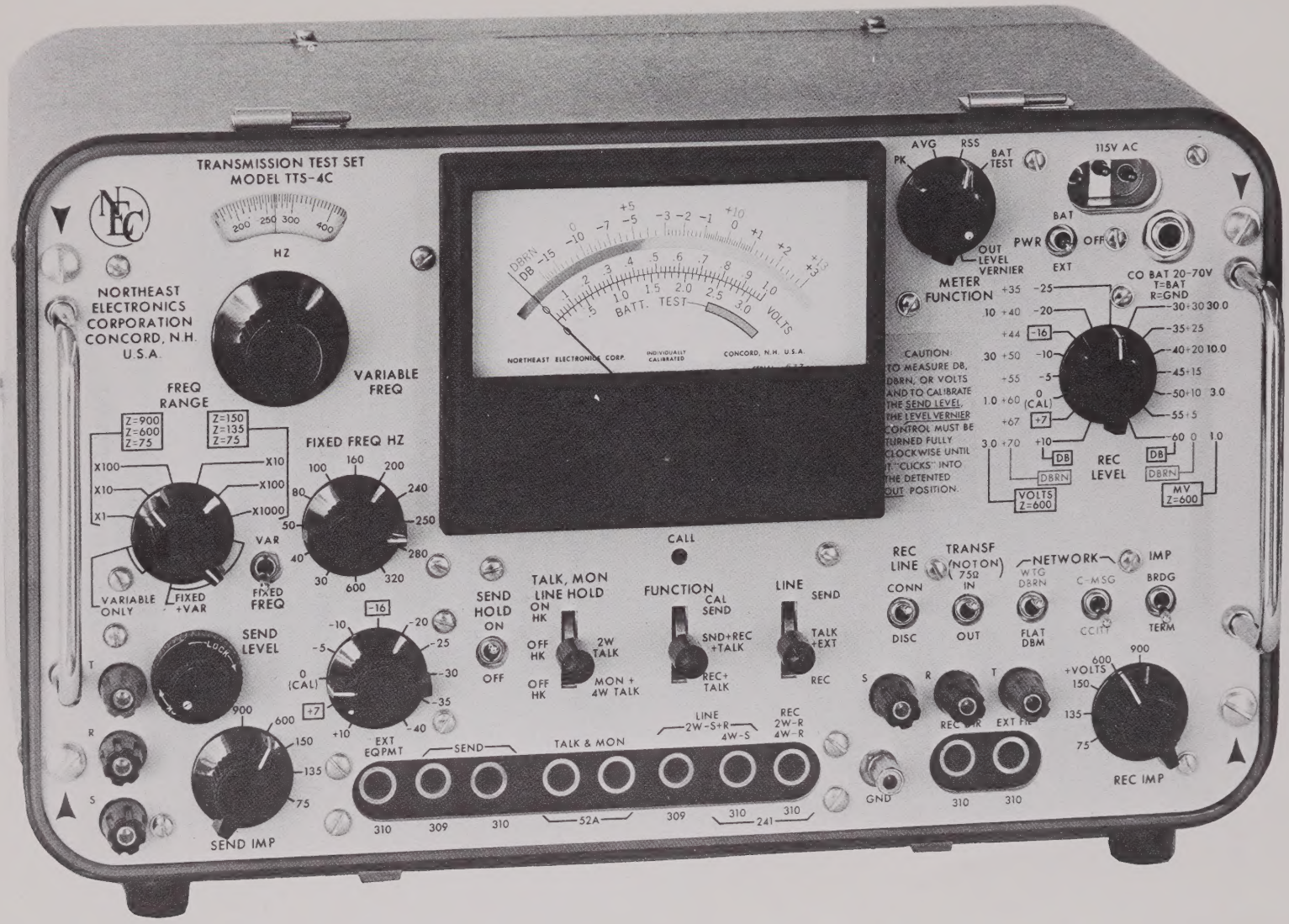
TRANSMISSION TEST SET
MODEL TTS-4C
NORTHEAST ELECTRONICS CORPORATION CONCORD, N.H. U.S.A.
HZ
VARIABLE FREQ
FREQ RANGE
Z=900 Z=600 Z=75
Z=150 Z=135 Z=75
X100 X10 X1 X10 X100 X1000
VARIABLE ONLY
FIXED +VAR
VAR
FIXED FREQ
FIXED FREQ HZ
100 160 200 240 250 280 320 600 40 30 80 50
SEND LEVEL
LOCK
T R S
SEND IMP
900 600 150 135 75
-16 -10 -5 0 (CAL) +7 -20 -25 -30 -35 -40 +10
EXT EQPMT
SEND HOLD ON OFF
TALK, MON LINE HOLD ON HK OFF HK 2W TALK MON + 4W TALK OFF HK
CALL
FUNCTION CAL SEND SND+REC +TALK REC+ TALK
LINE SEND TALK +EXT REC
SEND
TALK & MON
LINE 2W-S+R 4W-S
REC 2W-R 4W-R
310 309 310 52A 309 310 241 310
DBRN DB -15 BATT. TEST VOLTS
NORTHEAST ELECTRONICS CORP.
INDIVIDUALLY CALIBRATED
CONCORD, N.H. U.S.A.
AVG RSS PK BAT TEST
OUT LEVEL VERNIER
METER FUNCTION
115V AC
BAT PWR OFF EXT
CAUTION: TO MEASURE DB, DBRN, OR VOLTS AND TO CALIBRATE THE SEND LEVEL, THE LEVEL VERNIER CONTROL MUST BE TURNED FULLY CLOCKWISE UNTIL IT "CLICKS" INTO THE DETENTED OUT POSITION.
CO BAT 20-70V T=BAT R=GND
REC LEVEL
DB DBRN VOLTS Z=600 MV Z=600
REC LINE CONN DISC TRANSF (NOTON) 75Ω IN OUT
NETWORK WTG DBRN FLAT DBM C-MSG CCITT
IMP BRDG TERM
S R T GND
REC IMP
+VOLTS 600 900 150 135 75
310 310

SECTION 1

GENERAL DESCRIPTION

GENERAL

1.1 The Model TTS 4C is a portable transistorized self-contained transmission test set designed to perform transmission, noise and voltage measurements over a wide range of telecommunications circuits ranging from local exchange circuits to 4-wire toll and special service circuits. The set is designed to operate in a frequency range from 30 Hz to 560 kHz.

1.2 The set contains an oscillator, level measuring circuits, filters, precision terminations, impedance matching circuits, talk and monitor circuits, hold coils and switching facilities which are provided to conveniently select the various combinations of features. The set can be operated from internal batteries, from any central office battery from 24 to 70V and from an AC supply.

RECEIVE SECTION

1.3 The level meter in the basic Receive section provides accurate level measurements over a frequency range from 100 to 500,000 Hz; measurements at slightly reduced accuracy can be made over the range of 50 Hz to 1 MHz. The level meter has a maximum sensitivity of -60 dBm at the 0 dBm point on the meter scale and a minimum sensitivity corresponding to +10 dBm for a 0 dBm reading. The scale is calibrated from -15 dBm to +3 dBm. Thus the total range of levels which can be measured extends from -75 dBm to +13 dBm. A weighting network, which incorporates additional gain can be switched in for noise measurements. For this application, the meter scale is also calibrated in dBrn, thereby permitting noise measurements from -5 dBrn to +83 dBrn. In addition, the set provides AC voltage measurements from 100μV to 3.0V. To use the set as a voltmeter, the RECEIVE IMPEDANCE switch must be in the 600Ω position; either the bridging or terminated mode of operation may be used in this case.

1.4 By means of the REC IMP switch, the receive section can be switched for operation on circuits with impedances of 75, 135, 150, 600 and 900Ω and by means of the IMP switch it can be operated either in a high impedance bridging or terminated mode on circuits having these impedances. The input amplifier circuits are balanced to provide suppression of "longitudinal" components for all impedances, except 75Ω. In addition, balanced input transformers can be switched in by means of the TRANSF switch to permit measurements on circuits with high longitudinal voltages. The REC IMP switch automatically connects a low frequency transformer to the TRANSF switch when it is in the 600 or 900Ω position and a high frequency transformer when it is in the 135 or 150Ω position. The receive section is provided with excellent shielding and may be isolated from the LINE and SEND circuits by positioning the REC LINE switch to DISC; in this case, the circuit to be measured is connected to the REC DIR jack or to the REC DIR T-R terminals. The terminal marked S connects to the sleeve of the REC DIR jack. When the REC LINE switch is in the CONN position, the S terminal is extended to the sleeve of the REC 310 jack and the REC DIR T-R terminals are connected to the "disconnect" contacts of this jack and hence to the other circuits in the test set. In addition, a chassis ground terminal marked GND is located in the receive section.

1.5 A 15-position receive attenuator rotary switch, marked REC LEVEL, is provided. It controls the overall sensitivity providing 0 dB meter readings for input levels of +10, +7, 0, -5, -10, -16, -20, -25, -30, -35, -40, -45, -50, -55 and -60dB. The levels of +7 and -16 are provided to facilitate testing of 4-wire circuits;

levels of +5 and -15 dB can be substituted for the +7 and -16 dB levels on special models. A LEVEL VERNIER adjustment, which is controlled by means of the inside concentric control of the METER FUNCTION switch can be switched into the RECEIVE circuit. It permits any level to be read at the 0 dBm position on the meter scale. This feature permits reading level deviations from any pre-determined level. The vernier control is removed from the circuit in the fully CW position of the control. (NOTE: A "click" should be felt.) The detector circuit can be switched by means of the switch marked METER FUNCTION to provide Peak, Average or RSS (quasi-RMS) readings. When measuring a sinusoidal voltage, all three methods of detection will provide the same reading.

1.6 For noise measurements, a weighting network which incorporates an additional 20 dB of gain can be switched in by means of the switch marked NETWORK WTG/DBRN-FLAT/DBM. This switch selects the flat response when placed in the FLAT-DBM position and a weighting response when placed in the WTG-DBRN position. The switch marked NETWORK C MSG/CCITT selects either the C message network commonly used in the USA or the CCITT weighting network. Other networks or filters can be inserted by using the jack marked EXT FIL.

1.7 The Receive Section may also be used as a voltmeter. In this application, the REC IMP switch must be in the 600Ω position. When the IMP switch is in the BRDG position, the input impedance is approximately 100,000Ω when the TRANSF switch is in the OUT position and about 20,000Ω when it is in the IN position. In addition, a 600Ω termination may be added by moving the IMP switch to the TERM position.

SEND SECTION

1.8 The SEND Section consists of an extremely stable oscillator capable of generating frequencies from 30 Hz to 560 kHz and an output amplifier. Levels of +10 dBm to -40 dBm can be supplied to the output circuit through transformers which can be switched by means of the SEND IMP switch to match circuits having impedances of 75, 135, 150, 600 and 900Ω.

1.9 A switch marked FREQ-Var/Fixed selects either the continuously variable or the fixed frequency operation. The operating frequency is selected by either the FIXED FREQ rotary switch or the VAR-FREQ continuous control in connection with the FREQ RANGE switch which is marked X1, X10, X100, X10, X100, X1000. To provide optimum level stability, two output transformers are used. The transformer which is used for the lower frequencies is switched in when the SEND IMPEDANCE switch is in the 900 and 600Ω position. The high frequency transformer is switched in when the SEND IMPEDANCE switch is in the 150 or 135Ω position. No transformer is provided on the 75Ω output.

> CAUTION: The 75Ω output is not blocked for DC and must not be connected to circuits carrying DC.

The first three frequency ranges, X1, X10, X100, can be used with send impedances of 900, 600 and 75Ω. The last three frequency ranges, X10, X100, X1000, can be used with send impedances of 150, 135 and 75Ω. The last two frequency ranges, X100 and X1000, can be used only when the FREQ switch is in the VAR position. All other frequency ranges can be used with either fixed or variable frequencies. To prevent erroneous operation and to alert the operator, an interlock circuit interrupts the power supply to the output amplifier when an improper combination of frequency ranges and impedances has been selected.

1.10 The send level can be adjusted by means of a vernier control which is provided with a mechanical locking device and a rotary attenuator switch; these two share the designation SEND LEVEL. Unless the vernier SEND LEVEL control has been set to provide proper calibration, the level

markings of the SEND LEVEL attenuator are meaningless. There the SEND level must be calibrated before using the instrument. After the proper calibration procedure has been performed, the 10-position rotary SEND LEVEL attenuator switch provides send levels of +10, +7, 0, -5, -10, -16, -20, -25, -30, -35, and -40 dBm. The levels of +5 and -15 dBm can be substituted for the +7 and -16 dBm levels on special models. The vernier control of the SEND LEVEL also makes it possible to provide any other send level within the attenuator range. This use requires a special calibration procedure.

LINE SECTION

1.11 This group of circuits contains jacks to make connections to the 2-wire and 4-wire LINE circuits under test, TALK and MON jacks to connect a 52A or equivalent headset to the talk circuits in the set, an EXT EQPMT jack to connect external equipment to the circuit under the control of the FUNCTION and TALK MON and LINE HOLD switches and jacks to connect to the SEND circuits directly. Connections to the 2-wire LINE circuit and the SEND circuits may be made through either type 309 or 310 plugs; all other jacks use 310 type plugs.

1.12 The LINE switch is connected to the line jacks. Its function is to select the SEND, REC and TALK + EXT functions. Note that in the REC position it is necessary that the REC LINE switch is in the CONN position; furthermore, the REC IMP switch should be moved to the desired impedance and the IMP switch should be moved to either TERM or BRDG as required for the test to be made. In the SEND position, the desired frequency, impedance and levels should be selected. In the TALK + EXT position of the LINE switch, the line is extended through the EXT EQPMT jack to the built-in talk circuits; to use these functions it is necessary to insert a 52A or equivalent headset into the TALK & MON jacks. External equipment may be connected to the LINE by inserting a cord into the EXT EQPMT jack. This disconnects the talk circuit. In this case, the TALK-MON-LINE-HOLD switch controls a hold coil across the external equipment.

1.13 The TALK-MON-LINE-HOLD switch controls the talk and hold circuits. The hold circuit on the LINE jack is interrupted in the ON HK position of this switch and is connected across the line in the two other positions of this switch, regardless of the position of the FUNCTION or LINE switches. The receiver of the 52A headset is connected to the amplifier detector circuit in the REC section when the switch is in the MON and 4W TALK position and is connected to the talk circuits in the two other positions; the talk circuits are connected to the LINE when the FUNCTION switch is in the TALK and EXT EQPMT position. This permits use of the TALK circuits on both 4-wire and 2-wire circuits. When the switch is in the MON + 4W TALK position, the REC LEVEL control must be adjusted to provide a comfortable receive level.

1.14 The SEND section can be used independently from the rest of the equipment by inserting a plug into the SND 309 or 310 jack. Access to the send circuits can also be obtained on the T+R terminals provided on the front panel. Note however, that the T+R terminals will be connected to the line when the LINE switch is in the SEND position unless a dummy plug has been inserted in one of the two SEND jacks. The S terminal in the SEND section is connected to the sleeves of the SEND, LINE and EXT EQPMT jacks. The SEND HOLD switch controls an additional hold coil which is connected to the SEND circuits when they are used separately as described above.

1.15 The FUNCTION switch in its normal position, marked SND+REC+TALK, extends the control of the SEND, RECEIVE and TALK circuits to the LINE switch. In the CAL SEND position of the FUNCTION switch, it disconnects the send and receive circuits from the line circuits and interconnects them directly to permit calibration of the send level. (It should be noted that to calibrate the SEND signal, the REC

LINE switch should be in the CONN position, the IMP switch in the TERM position and the REC IMP switch on the same impedance as the SEND IMP switch. This is discussed in more detail under the section on calibration.) In the REC+TALK position, the FUNCTION switch disables the oscillator circuit while leaving the other circuits under the control of the LINE switch.

POWER

1.16 The set can be operated from 24 self-contained D cells, from central office batteries having a voltage of 20 to 70V or from an external 110V ac supply. Sets equipped to operate from 220V ac can be supplied on special order. To operate on the internal batteries, the PWR switch is placed in the BAT position; to operate from central office battery or from ac, the PWR switch is placed in the EXT position. The center position of the PWR switch is the OFF position and is so marked. A bracket is provided in the cover of the set to return the PWR switch to the OFF position if it should have been inadvertently left in the BAT position when the cover of the set is closed. The condition of the internal batteries can be checked by turning the METER FUNCTION switch to the BAT TEST position. The meter should read within or above the green arc marked BAT TEST.

1.17 Cover

The cover of the set contains a dial, a circuit to measure noise to ground and storage space for cords.

SECTION 2

TRANSMISSION PERFORMANCE

I. SEND SECTION

A. Frequency Range:

1. Variable: Dial marked 50 Hz to 560 Hz

a. Ranges: X1, X10, X100 and X1000. Provides continuous adjustment of frequency from 50 Hz to 560 kHz.

2. Fixed: Switch marked 30, 40, 50, 80, 100, 160, 200, 240, 250, 280, 320 and 600 Hz.

a. Ranges: X1, X10 and X100. Provides fixed frequency settings of 30 Hz to 60 kHz.

B. Frequency Accuracy:

1. Variable: ±5% of dial setting.

2. Fixed: ±2%

C. Frequency Response

1. 75Ω	±0.5 dB	50 Hz	to 560 kHz
2. 135,150Ω	±0.5 dB	5kHz	to 560 kHz
	±0.25 dB	5kHz	to 500 kHz
3. 600,900Ω	±0.5 dB	50kHz	to 50 kHz
	±0.25 dB	100 Hz	to 20 kHz

D. Level Range:

1. Attenuator Steps: +10, +7, 0, -5, -10, -16, -20, -25, -30, -35 and -40 dB.

2. Vernier: +1 dB, -7 dB variable from any of the above steps.

E. Level Accuracy: Calibrated with REC SECTION.

F. Attenuator Accuracy: (1 kHz reference) ±0.15 dB.

G. Total Harmonic Distortion: Less than 1% at any frequency.

H. Output Impedance:

1. 600, 900Ω ±5% 30 Hz to 10 kHz phase angle $<5^{\circ}$

2. 135, 150Ω ±5% 1 kHz to 100 kHz phase angle $<5^{\circ}$
±10% 100 kHz to 560 kHz phase angle $<10^{\circ}$

3. 75Ω ±5% 30 Hz to 560 kHz phase angle $<10^{\circ}$

I. Output Balance:

1. 600, 900Ω 100 Hz >90 dB
3 kHz >70 dB

2. 135, 150Ω 5 kHz >60 dB
560 kHz >30 dB

II. POWER SUPPLY

A. Internal Battery

1. 24 "D" size batteries.

2. Battery Life - approximately 250 hours when discharged 4 hrs/day.

B. Central Office Battery - operates from -20V dc to -70V dc.

C. AC Power - 115V ac 50 to 400 Hz 5 watts

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III. RECEIVE SECTION

A. Accuracy:

1. ±0.1 dB (1000 Hz, 0 dBm 600Ω 25°C ±10°C).

2. ±0.2 dB (1000 Hz, 0 dBm 600Ω 0°C to 50°C).

B. Step Attenuator Error: (Reference to 0 dB)

1. ±0.15 dB/step, maximum accumulated to -55 dB.

2. ±0.2 dB to -60 dB.

C. Meter Tracking

1. ±0.1 dB from 0 dB to ±1.0 dB
from 0 dB to ±2.0 dB
from 0 dB to ±3.0 dB

2. ±0.2 dB from 0 dB to -5.0 dB

3. ±0.5 dB from 0 dB to -10.0 dB

D. Overload Margin:

1. Approximately 5 dB above full-scale meter reading for all ranges.

E. Balanced Bridging Input Impedance (1000 Hz):

100KΩ without transformer
20KΩ with transformer

F. Frequency Response:

1. Rec Imp 135Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level +10 dB to -55 dB

±0.1 dB 100 Hz to 100 kHz
±0.2 dB 100 kHz to 500 kHz
±0.5 dB 50 Hz to 1 MHz
±3.0 dB 20 Hz to 1.5 MHz

2. REC IMP 135Ω
Transformer IN
Meter Function RSS or AVG
Rec Level +10 dB to -55 dB

±0.1 dB 500 Hz to 100 kHz
±0.2 dB 200 Hz to 100 kHz
±0.5 dB 100 Hz to 500 kHz
±3.0 dB 50 Hz to 1.5 MHz

3. Rec Imp 135Ω
Transformer OUT
Meter Function Peak
Rec Level +10 dB to -55 dB

±0.1 dB 500 Hz to 50 kHz
±0.2 dB 300 Hz to 80 kHz
±0.5 dB 200 Hz to 100 kHz
±3.0 dB 20 Hz to 500 kHz

4. Rec Imp 135Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level -60 dB

±0.1 dB 200 Hz to 80 kHz
±0.2 dB 100 Hz to 100 kHz
±0.5 dB 50 Hz to 200 kHz
±3.0 dB 20 Hz to 1 MHz

5. Rec Imp 75Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 500 Hz to 100 kHz
±0.2 dB 200 Hz to 500 kHz
±0.5 dB 100 Hz to 800 kHz
±3.0 dB 20 Hz to 1.5 MHz

6. Rec Imp 150Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 100 Hz to 100 kHz
±0.2 dB 100 kHz to 400 kHz
±0.5 dB 50 Hz to 600 kHz
±3.0 dB 20 Hz to 1.5 MHz

7. Rec Imp 150Ω
Transformer IN
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 500 Hz to 100 kHz
±0.2 dB 200 Hz to 200 kHz
±0.5 dB 100 Hz to 1 MHz
±3.0 dB 50 Hz to 1.5 MHz

8. Rec Imp 600Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 100 kHz
±0.2 dB 100 Hz to 200 kHz
±0.5 dB 50 Hz to 500 kHz
±3.0 dB 20 Hz to 1 MHz

9. Rec Imp 600Ω
Transformer IN
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 10 kHz
±0.2 dB 100 Hz to 20 kHz
±0.5 dB 50 Hz to 50 kHz
±3.0 dB 20 Hz to 100 kHz

10. Rec Imp 900Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 100 kHz
±0.2 dB 100 Hz to 500 kHz
±0.5 dB 50 Hz to 800 kHz
±3.0 dB 20 Hz to 1 MHz

11. Rec Imp 900Ω
Transformer IN
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 10 kHz
±0.2 dB 100 Hz to 20 kHz
±0.5 dB 50 Hz to 50 kHz
±3.0 dB 20 Hz to 100 kHz

G. Input Impedance

1. 75Ω ±5% 1 kHz to 1 MHz
phase angle < 5°

±10% 100 Hz to 1 MHz
phase angle < 20°

2. 135, 150Ω ±5% 500 Hz to 50 kHz
phase angle < 5°

±10% 100 Hz to 100 kHz
phase angle < 15°

3. 600, 900Ω ±5% 100 Hz to 10 kHz
phase angle < 5°

±10% 100 Hz to 100 kHz
phase angle < 20°

H. Balance (Common mode rejection)

1. 135, 150Ω 70 dB 200 Hz to 1 kHz
50 dB 1 kHz to 100 kHz
40 dB 100 kHz to 500 kHz

2. 600, 900Ω 90 dB 100 Hz to 1 kHz
40 dB 1 kHz to 100 kHz

I. Weighting Network Frequency Response

Temperature: 25°C

C Message

Reference: 0 dB @ 1kHz
-3 dB from 570 Hz to 750Hz and 2.1 kHz to 2.9 kHz.

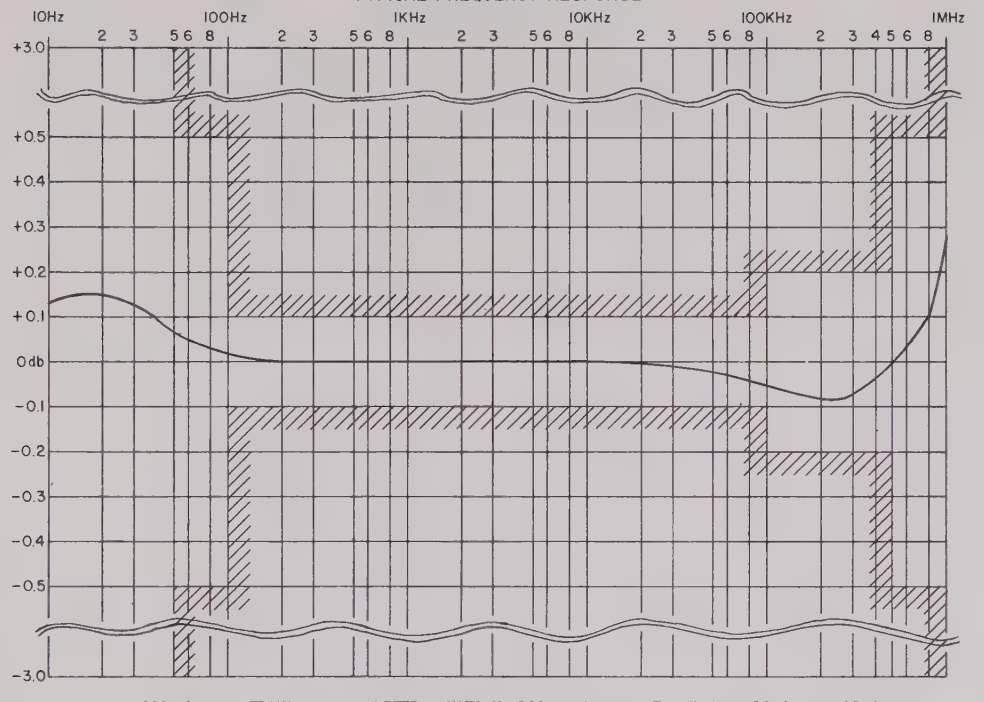
-40 dB from 90 Hz to 150 Hz and 4.8 kHz to 7.2 kHz.

CCITT

Reference: 0 dB @ 800 Hz
-3 dB from 570 Hz to 750 Hz and 2.1 kHz to 2.9 kHz.

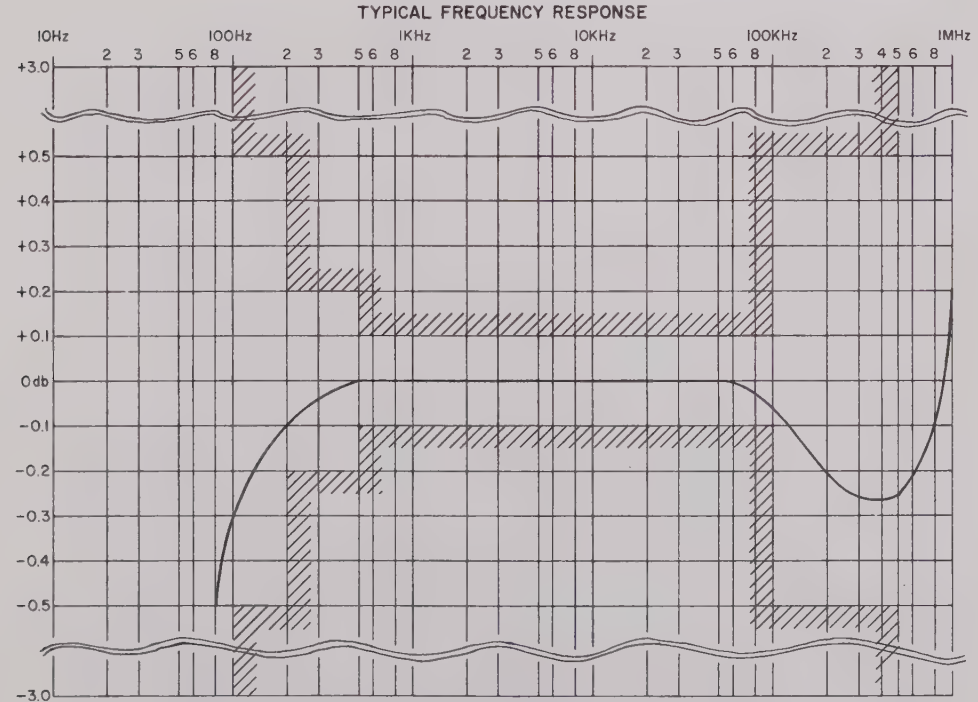
-40 dB from 90 Hz to 150 Hz and 4.8 kHz to 7.2 kHz.

TYPICAL FREQUENCY RESPONSE



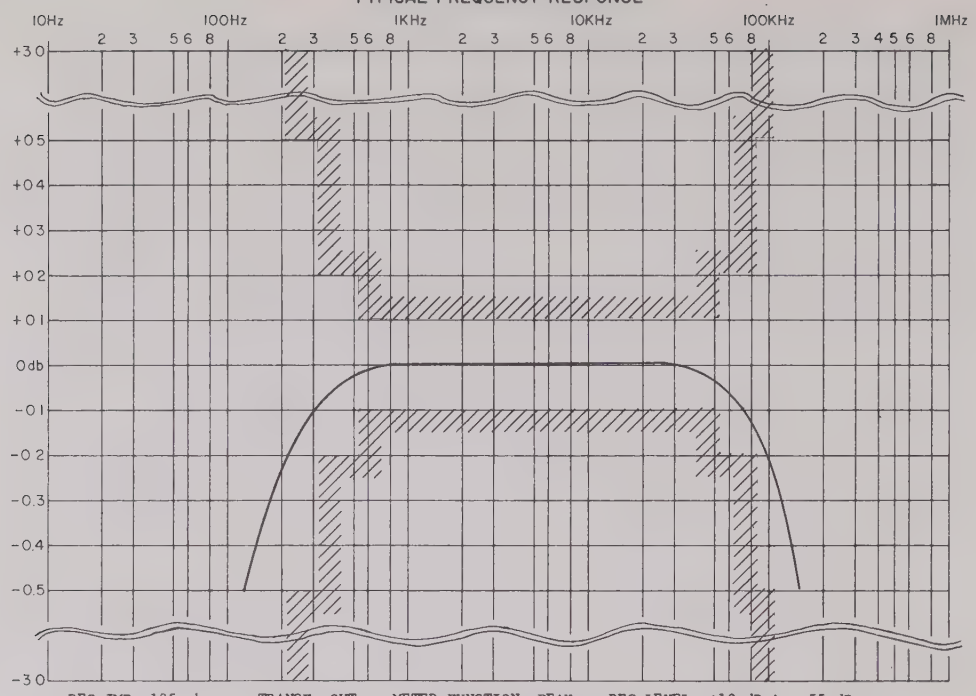
REC IMP 135 ohms TRANSF out METER FUNCTION RSS or AVG REC LEVEL +10 dB to -55 dB

TYPICAL FREQUENCY RESPONSE



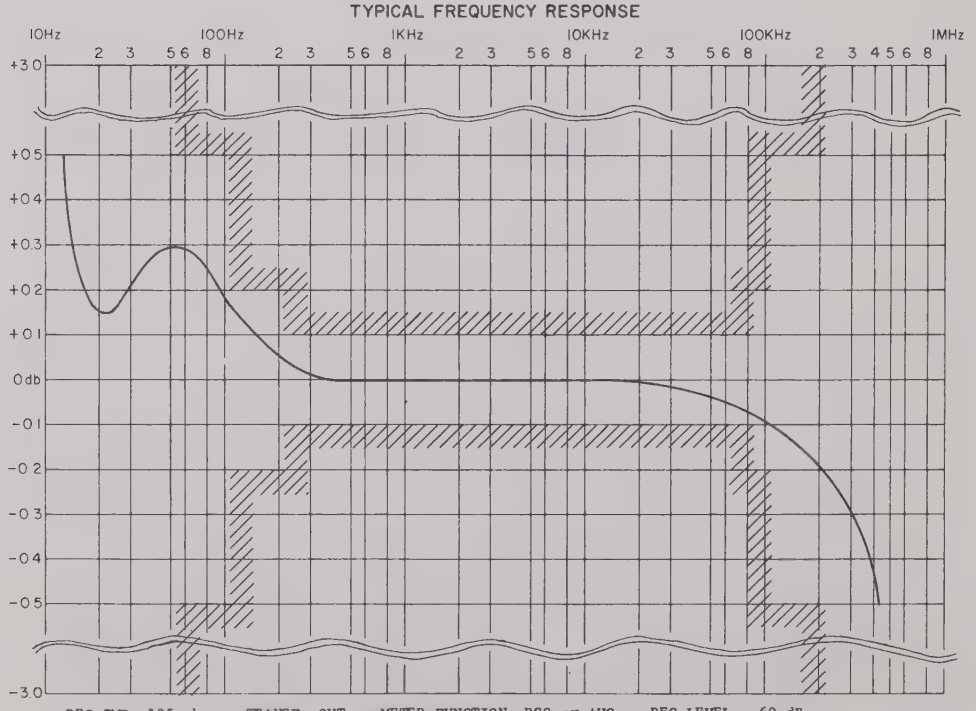
REC IMP 135 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL +10 dB to -55 dB

TYPICAL FREQUENCY RESPONSE



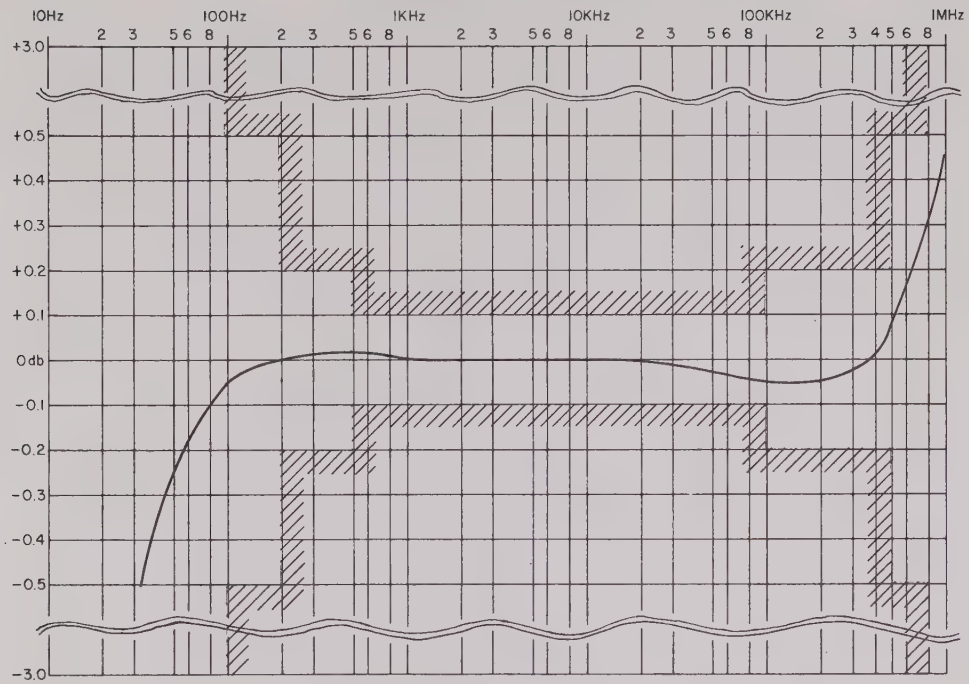
REC IMP 135 ohms TRANSF OUT METER FUNCTION PEAK REC LEVEL +10 dB to -55 dB

TYPICAL FREQUENCY RESPONSE



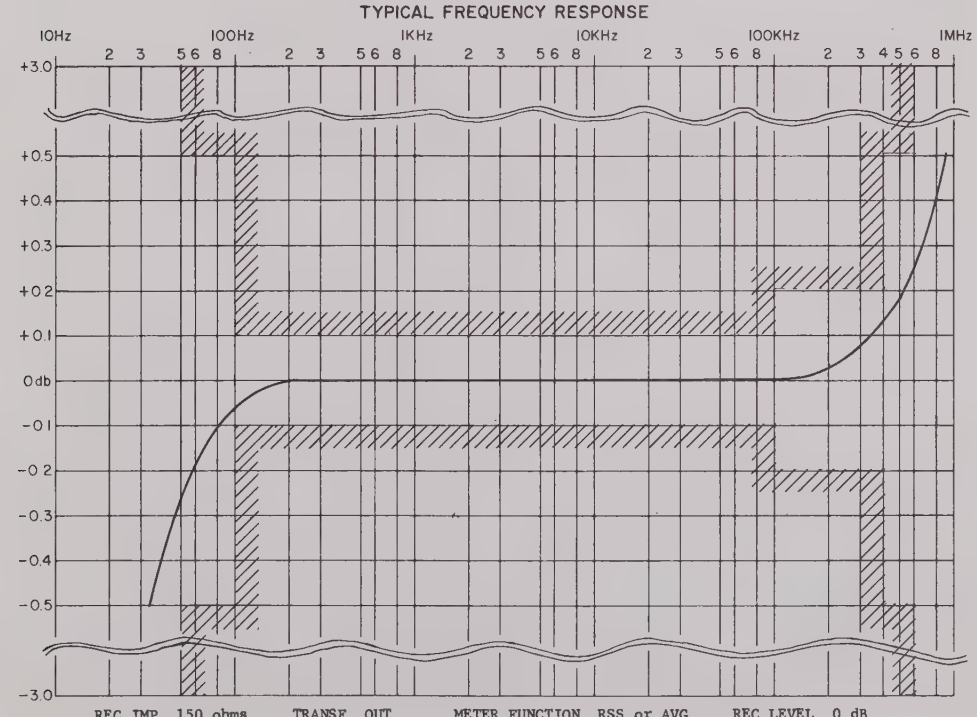
REC IMP 135 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL -60 dB

TYPICAL FREQUENCY RESPONSE



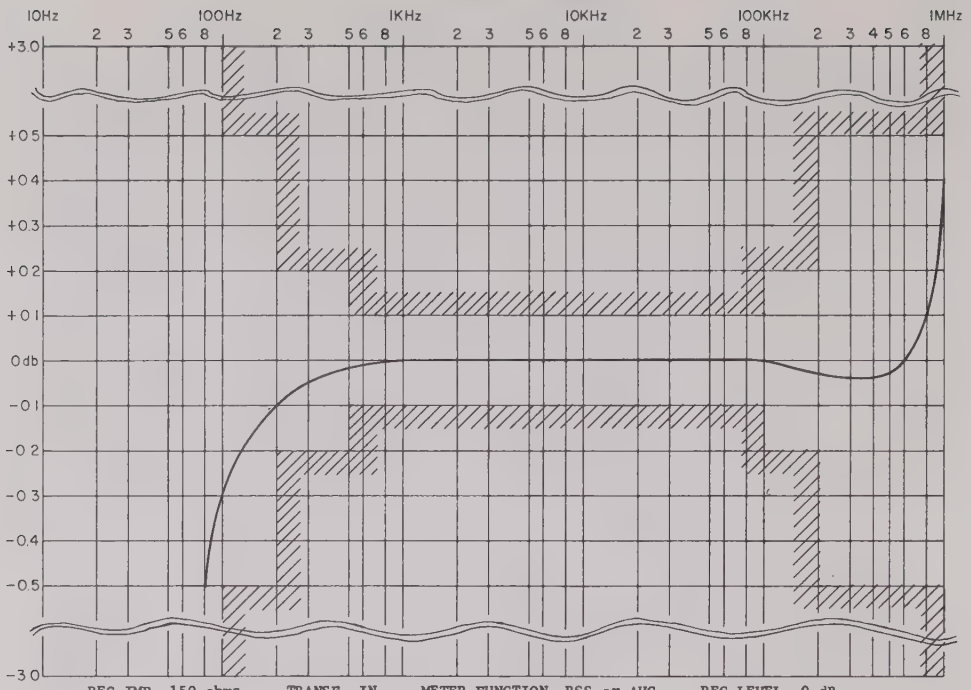
REC IMP 75 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



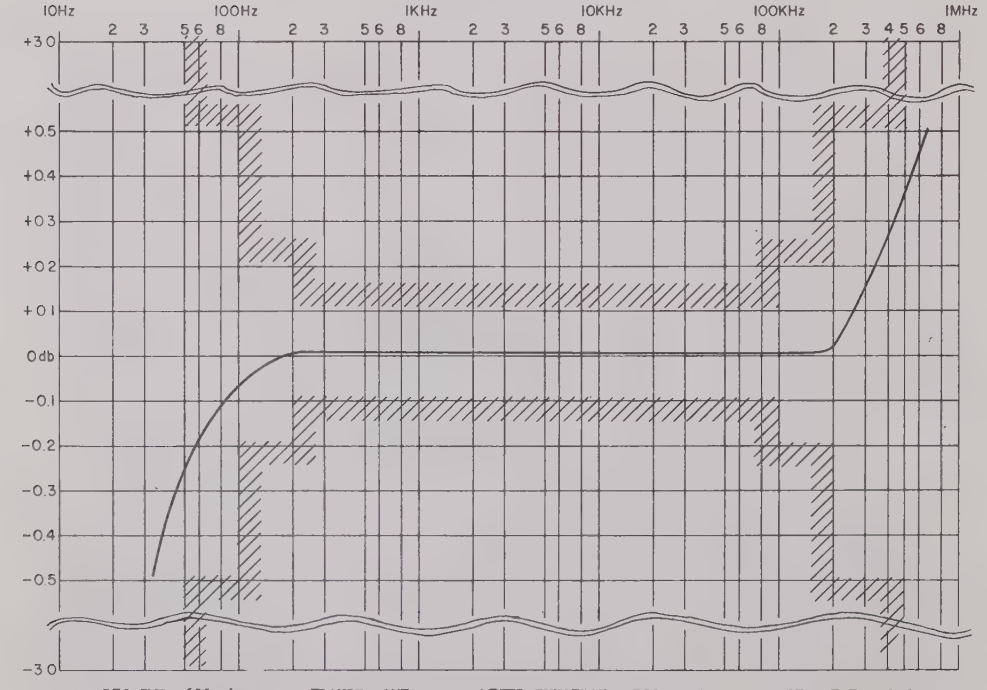
REC IMP 150 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



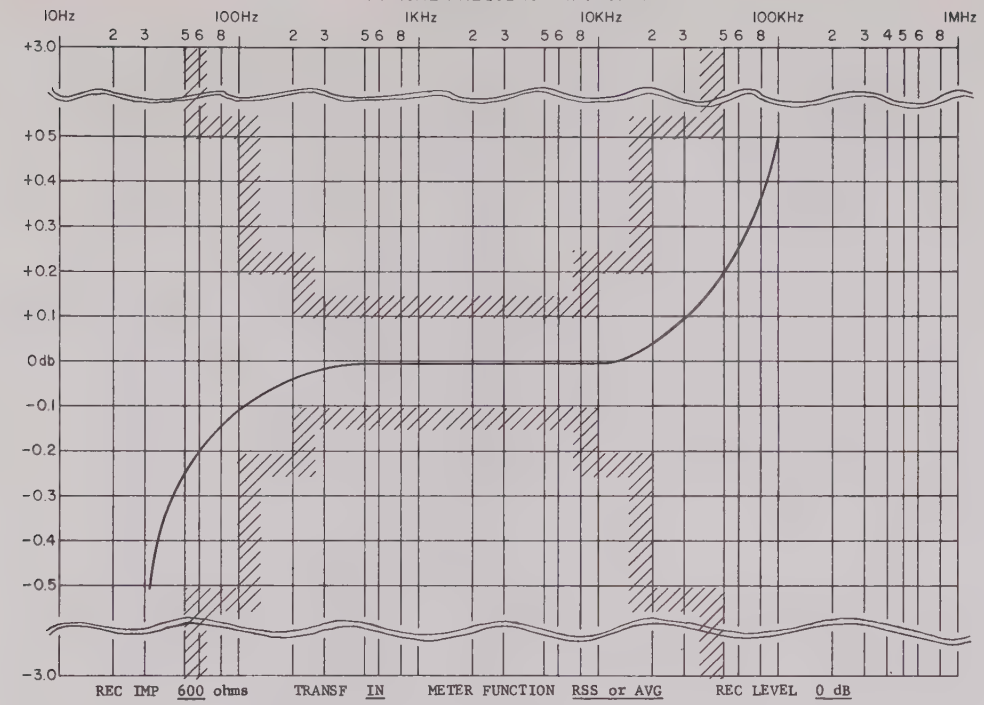
REC IMP 150 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



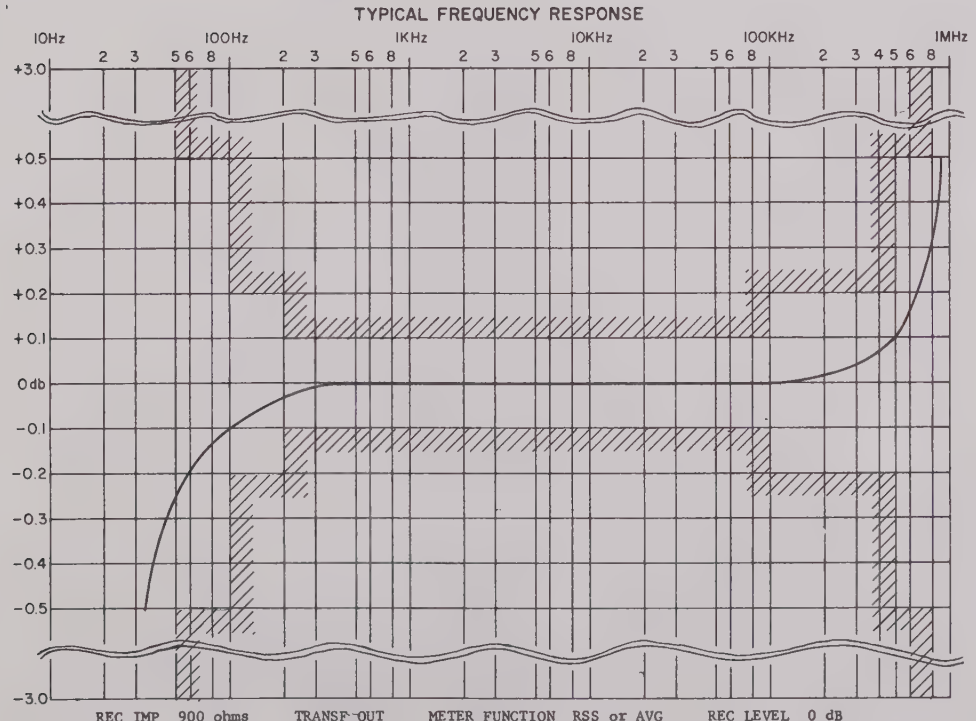
REC IMP 600 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



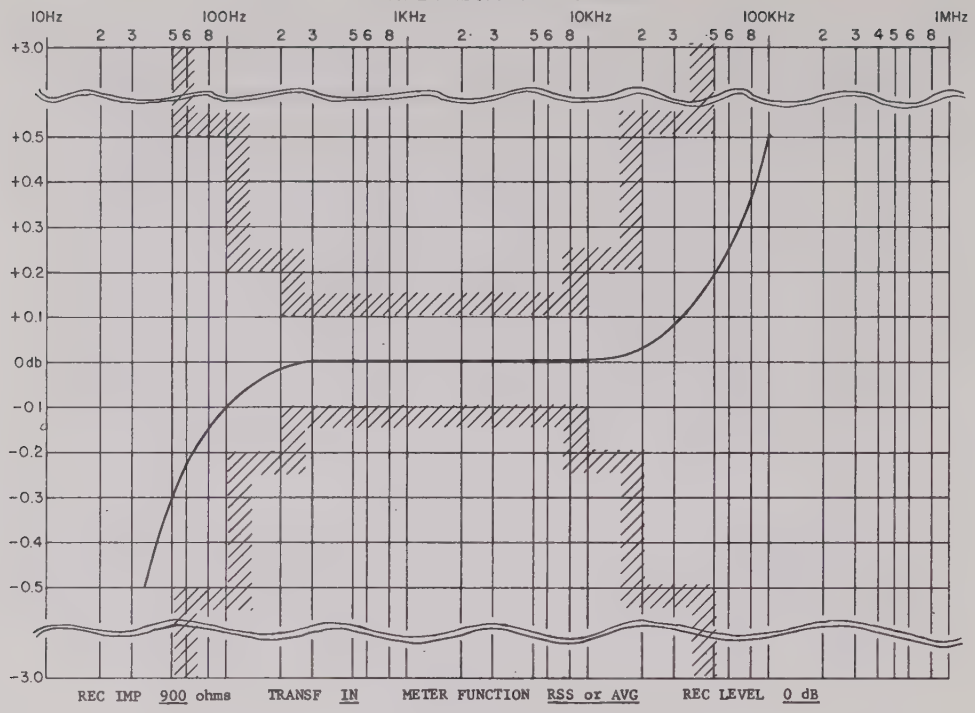
REC IMP 600 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



REC IMP 900 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



SECTION 3

CIRCUIT DESCRIPTION

3.1 RECEIVE SECTION

The receive section contains three amplifiers connected in tandem, level controls, impedance selection and termination selection devices and provisions for inserting noise measuring circuits.

The first amplifier is a differential amplifier which provides suppression of longitudinal components for input levels below -10 dBm. For higher levels of these components further suppression can be obtained by inserting an input transformer. A low frequency transformer which operates between 50 and 20,000 Hz is inserted in the 600 and 900Ω positions of the REC IMP switch and a high frequency transformer is inserted in the 135 and 150Ω positions. The high frequency transformer covers 500 to 500,000 Hz. For the controls and their operation, refer to the sections entitled General Description and Operation.

The input amplifier has an input impedance of 100,000Ω and a gain of approximately 10 dB. This gain is varied by the REC IMP switch in such a way as to maintain calibration of the level measuring circuits when they are used on other impedances. The input of the receive section can be switched to provide either BRIDGING or TERMINATED operation. DC blocking is provided in all receive operations. For input levels above -20 dB, starting at -16 dB, a 30 dB fixed attenuator is inserted ahead of the input amplifier under the control of the REC LEVEL switch. The output impedance of this amplifier is less than 10Ω.

The intermediate amplifier provides a gain which can range between 20 and 30 dB, depending on the setting of the REC LEVEL control. The input impedance of this amplifier is approximately 30,000Ω and the output impedance approximately 400Ω. When the NETWORK function is used, its weighted 20 dB amplifier is inserted between the input amplifier and the intermediate amplifier; the same applies to external filters.

The meter amplifier can be switched to provide AVG, RSS or PK (peak) detection.

The average and peak circuits are both conventional. The peak detecting circuit is usable to 100 kHz. In the RSS position, the meter is supplied partially by the AVG and partially by the peak circuits. On a sine wave input, the three different types of detection will provide the same reading. The LEVEL VERNIER control is inserted between the intermediate amplifier and the detector amplifier.

3.2 SEND SECTION

The oscillator uses a conventional Weinbridge circuit equipped with thermistor stabilization. The oscillator circuit drives an output amplifier and it in turn drives the external circuits through transformers. A low frequency transformer is used in the 600 and 900Ω positions and a high frequency transformer is used in the 135 and 150Ω positions. A 75Ω output is available, it does not contain an output transformer and is not blocked for DC. For the controls and their operation, refer to the sections entitled General Description and Operation.

3.3 LINE SECTION

This section contains talk and monitoring circuits, hold coils and switching. The operations of its controls is explained in the General Description and Operation sections.

3.4 POWER SUPPLY

The regulated power supply is of a conventional design; it delivers about 12 volts. When the lid of the set is closed, the PWR switch is automatically returned to the OFF position if it was in the BAT position. This prevents running down the internal batteries.

3.5 COVER

The cover of this set contains a dial, a circuit to measure noise to ground and space for storing of cords and tools.

SECTION 4

CALIBRATION AND MAINTENANCE

4.1 CALIBRATION

If, in the course of routine calibration, it is established that a readjustment of the receive section sensitivity is required, the following instructions should be followed.

CAUTION: MAKE SURE THAT THE EQUIPMENT USED IN CALIBRATING THE TTS 4C IS WORKING PROPERLY BEFORE DECIDING THAT ANY RE-CALIBRATION OF THE TTS 4C SHOULD BE PERFORMED.

1. Place the following controls in the positions as listed:

REC IMP	600
IMP	TERM
REC LINE	DISC
TRANSF	OUT
NETWORK	FLAT DBM
	C MSG
REC LEVEL	0 dB (CAL)

2. Remove the set from the case and leaving the battery connection intact, turn PWR switch to BAT. External power may be used when calibrating set if more convenient. If using internal batteries, place the METER FUNCTION switch to the BAT TEST position to ensure that error will not result from worn-out batteries.

3. Place the FUNCTION switch to the RSS position and connect a 1 kHz, 0 dB (600Ω source) signal to the jack or the T and R binding posts. Note: 0 dB should be calibrated from an accurate source.

CAUTION: The LEVEL VERNIER control must be in the detented (OUT) position, i.e. in the fully clockwise position.

Adjust potentiometer R1021 for ±0.02 dB reading.

4. Place the FUNCTION switch to the AVG position and adjust potentiometer R1030 for +0.02 dB meter reading.

5. Place the FUNCTION switch to the PK position and adjust potentiometer R1015 for +0.2 dB meter reading.

Note: The above steps will allow recalibration for errors of approximately ±0.50 dB. Any error exceeding this would indicate a malfunction in the set and indicates the need for factory repairs.

6. Put a dab of glyptol on the shafts of R1015, R1021 and R1030 to secure them in position.

7. Replace the set in the case.

Note: Calibration at a +0.02 dB reading for a 0.00 dBm input signal is recommended because it splits the error resulting from the approximately 0.05 dB insertion loss of the transformer.

If the set is primarily used with the transformer in, then calibration in this condition may be preferred. Similarly, if the set is primarily used without the input transformer, this may be the preferred calibration method.

4.2 MAINTENANCE

a. Battery Replacement. To replace batteries, remove the screws which hold the lower part of the case and remove it. After installing new batteries, use the BAT TEST switch position to check them before replacing the lower part of the case.

b. Circuit Maintenance. The circuits of the TTS 4 should not require maintenance. If abnormal operation is observed, it is suggested to return the set to the factory.

If field repairs are necessary, the circuit diagrams, which contain the voltages at critical points, will provide sufficient information, when used in combination with the block diagram and the table of levels in the receive and send sections.

SECTION 5

OPERATION

5.1 The GENERAL OPERATING INSTRUCTIONS are contained in Appendix 1 of this manual.

SECTION 6

ELECTRONIC PARTS LIST

6.1 INTRODUCTION. The following pages contain the parts list for the Model TTS 4C Transmission Test Set.

6.2 FSCM Code Numbers. This is the Federal Supply Code of Manufacturers as issued October 1969. A list of codes and their respective manufacturers is given below.

LIST OF MANUFACTURERS

Code No.	
01121	Allen-Bradley, Milwaukee, Wis. 53204
01295	Texas Instruments Inc. Semiconductor Div. Dallas, Texas 75231
03888	Pyrofilm Resistors Co. Inc. Cedar Knoll, N.J. 07927
05397	Union Carbide Corp. N.Y. N. Y. 10017
05844	Callins Industries Inc. Greenfield, Tenn. 38230
06540	Amatom Electronics Hardware Co. Inc. New Rochelle, N. Y. 10801
06819	Northeast Electronics Corp. Concord, N.H. 03301
07716	IRC Division of TRW Inc. New Castle, Del. 19720
09353	C&K Components Inc. Newton, Mass. 02158
12065	Transistron Electronics Corp. E. Boston, Mass. 02128
13606	Sprague Electric Co. Transistor Div. Concord, N.H. 03301
15873	Motorola Inc. Arcade, N.J. 14009
17803	Fairchild Semiconductor Div. Mountain View Cailf. 94041
22650	Whale Electronics Inc. Nashville, Tenn. 37204
24138	International Electronics Corp. Melville, LI, N.Y. 11746
49671	RCA Corp. N.Y. N. Y. 10020
71450	CTS Corp. Elkhart, Ind. 46514
71590	Centralab Milwaukee, Wis. 53201
72982	Erie Technological Products Inc. Erie, Pa. 16512
76854	Oak MFG. Co. Div. of Oak Electro/Netics Corp. Crystal Lake . Ill. 60014
80223	United Transformer Co. N.Y. N. Y. 10013
83330	Smith Herman H. Inc. Brooklyn, N.Y. 11207
84171	ARCO Electronics Inc. Great Neck, N.Y. 11022
84411	TRW Capacitor Div. Ogallala, Neb. 69153
94322	Tel&Labs Inc. Manchester, N.H. 69153

PC Bd. E95319 Oscillator Board

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
C101	C: 100μF 3V	05844	APD 051
C102	C: 50μF 15V	13606	TE 1160
C103	C: 22μF 6V	05397	K22W6K
C104	C: 500μF 3V	05844	APD 101
C105	C: 0.47μF 25V	13606	5C11
C106	C: 68pf 500V	84171	CM15E680J
C107	C: 100μF 3V	05844	APD 051
C108	C: 0.47μF 25V	13606	5C11
C109	C: 100μF 3V	05844	APD 051
C110	C: 0.47μF 25V	13606	5C11
C111	C: 1000μF 12V	05844	9-85PSD
C112	C: 120pf 1Kv NPO	13606	10TCC-T12
C113	C: 8-50pf	72982	539-00234E
C114	C: 100μF 15V	22650	18-375-100-15-8PA
C115	C: 4.7pf	13606	10TCCV47
R101	R: 3K 5% ¼W	01121	RC07
R102	Pot: 10K	71450	UPE200RE-1
R103	R: 51Ω 5% ¼W	01121	RC07
R104	R: 100Ω 10% ¼W	01121	RC07
R105	R: 18Ω 10% ¼W	01121	RC07
R106	Pot: 100Ω	71450	UPE200RE-1
R107	R: 56K 10% ¼W	01121	RC07
R108	R: 24K 5% ¼W	01121	RC07
R109	R: 9.31K 1% 1/8W	07716	CEATO
R110	R: 120Ω 10% ¼W	01121	RC07
R111	R: 2.2K 10% ¼W	01121	RC07
R112	R: 160Ω 5% ¼W	01121	RC07
R113, R114	R: 68Ω 10% ¼W	01121	RC07
R115	R: 490Ω 1% 1/8W	07716	CEATO
Q101	Transistor FET P Channel	15873	MPF-152
Q102 thru 104	Transistors: PNP	15873	2N3905
Q105	Transistor: NPN	15873	2N3903
CR101 thru 103	Diodes	12065	1N4148
RT101	Thermistor	15801	GB38V2
RT102, 103	Thermistor	15801	KA3IL1

PC Bd. E95335 Frequency Padding Board

C201	C: 8.2pf 1Kv	13606	10TCPV82
C202	C: 1.5-8pf	72982	557091COPO10R
C203	C: 5-25pf	72982	557091COPO39R

PC Bd. E95326 Impedance Board

Ref Desig.	Description	Manufacturer (FSCM Code #)	Part Number
C301, C302	C: sel val		
C303	C: 2.0μF 150V	13606	121P20591R5S4
R301	R: 665Ω 1% ½W	07716	CECTO
R302	R: 15.8Ω 1% ½W	07716	CECTO
R303	R: 665Ω 1% ½W	07716	CECTO
R304	R: 2430Ω 1% ½W	07716	CECTO
R305	R: 38.3Ω 1% ½W	07716	CECTO
R306 and R306A	R: 8.36Ω 1% ½W	07716	CECTO
R307	R: 1430Ω 1% ½W	07716	CECTO
R308	R: 30.9Ω 1% ½W	07716	CECTO
R309	R: 255Ω 1% ½W	07716	CECTO
R310	R: 34.8Ω 1% ½W	07716	CECTO
R311	R: 27.4Ω 1% ½W	07716	CECTO
R312	R: 34.8Ω 1% ½W	07716	CECTO
R313	R: 27.4Ω 1% ½W	07716	CECTO
R314 and 315	R: 450Ω ¼% 1/10W	94322	CR 16
R316, R317	R: 300Ω ¼% 1/10W	94322	CR 16
R318, 319	R75Ω 1% ½W	07716	CECTO
R320, 321	R: 68.1Ω 1% ½W	07716	CECTO

PC Bd. E95327 Output Amplifier Board

C401	C: 20μF 15V	13606	TE 1157
C402	C: 100μF 12V	22650	16-375-100-12-8PA
C403, 404	C: 20μF 15V	13606	TE 1157
C405	C: 200μF 20V	05844	APD 115
C406	C: 830μF 15V	22650	28-750-830-15-8PA
C407	C: 68pf	84171	CM15E680J
R401, R402	R: 180K 10% ¼W	01121	RC07
R403	R: 6.19K 1% 1/8W	07716	CEATO
R403A	R: 47K 10% ¼W	01121	RC07
R404	R: 1.5K 10% ¼W	01121	RC07
R405	R: 620Ω 5% ¼W	01121	RC07
R406	R: 1.8K 10% ¼W	01121	RC07
R407, R408	R: 10Ω 10% ¼W	01121	RC07
R409	R: 75Ω 1% 1/8W	07716	CEATO
R410	R: 3.01K 1% 1/8W	07716	CEATO
R411	R: 10Ω 10% ¼W	01121	RC07
Q401	Transistor: NPN	15873	MPS 651b
Q402, 403	Transistor: PNP	15873	2N3905
Q404	Transistor: NPN	15873	2N3903
CR401, CR402	Diodes	12065	1N4148

PC Bd. E95351 Bridge Fixed Cap. Board

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
C501	C: 0.27μF 35V	13606	490P2745R35
C502	C: selected value		
C503	C: 0.027μF 50V 5%	05397	KA2702FK50J
C504	C: selected value		
C505	C: 0.0027μF 50V 5%	05397	KA2701FK50J
C506	C: selected value		
C507	C: 0.27μF 35V	13606	490P2745R35
C508	C: selected value		
C509	C: 0.027μF 50V 5%	05397	KA2702FK50J
C510	C: selected value		
C511	C: 0.0027μF 50V 5%	05397	KA2701FK50J
C512	C: selected value		

PC Bd. E95477 Resistor Padding Board

R601 thru 608	R: sel val	01121	RC07

PC Bd. E95360 30 dB Attenuator and Frequency Adjust

C701	C: 11-110pf trimmer	72982	503-00162F
C702	C: 1.5-8pf trimmer	72982	539-00298A
C703	C: 5pf 1Kv	71590	DD 050
C704	C: 15pf 1Kv	71590	DD 150
R701	Pot: 1K	71450	UPE200RE-1
R702,	R: 390K 10% $\frac{1}{2}$W	01121	RC20
R703	Pot: 500K	71450	UPE200RE-1
R704	R: 2.7K 1% 1/8W	07716	CEATO
R705, 706	R: 390K 10% $\frac{1}{2}$W	01121	RC20

PC Bd. E95273 Balance Amplifier

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
C801	C: 100μF 20V	24138	APD 095
C802, C803	C: 2.2μF 100V NP	22650	51-6838
C804, C805	C: 2.2μF 35V	05397	K2R2W35K
C806	C: 8-50pf trimmer	72982	539-00234E
C807	C: 100μF 20V	24138	APD 095
C808	C: 100μF 20V	24138	APD 095
R806	R: 301Ω1% 1/8W	07716	CEATO
R807	R: 487Ω 1% 1/8W	07717	CEATO
R808	R: 536Ω 1% 1/8W	07716	CEATO
R809	R: 2.94K 1% 1/8W	07716	CEATO
R810	R: 15.8K 1% 1/8W	07716	CEATO
R815	R: 470K 10% ½W	01121	RC20
R816	R: 100Ω 10% ½W	01121	RC20
R817	R: 300K 5% ½W	01121	RC20
R818	R: 510K 5% ½W	01121	RC20
R819, R820	R: 10K 10% ½W	01121	RC20
R821	R: 510Ω 5% ½W	01121	RC20
R822	R: 1K 10% ½W	01121	RC20
R823	R: 909Ω 1% 1/8W	07716	CEATO
R824	R: 300K 5% ½W	01121	RC20
R825	R: 150K 5% ½W	01121	RC20
R826	R: 220K 10% ½W	01121	RC20
R827	R: 9.1K 5% ½W	01121	RC20
R828	R: 4.87K 1% 1/8W	07716	CEATO
R829	R: 6.2K 5% ½W	01121	RC20
R830, R831	R: 6.04K 1% 1/8W	07716	CEATO
R830A	Pot: 5K	71450	UPE 200RE-1
R832	R: 100Ω 10% ½W	01121	RC20
R833	R: 16K 5% ½W	01121	RC20
R834	R: 2.7K 5% ½W	01121	RC20
Q801	Transistors: PNP	15873	2N3905
Q802	Transistors: NPN	15873	2N3903
Q803	Transistors: NPN	15873	2N3903
Q804	Transistors: PNP	15873	2N3905
Q805	Transistors: PNP	15873	2N3905
Q806	Transistors: NPN	15873	2N3903
Q807	Transistors: NPN	15873	2N3903
Q808	Transistors: PNP	15873	2N3905
CR801	Diode	12065	1N4148

PC Bd. E95353 Inter. Atten.

R901	R: 715Ω ½% 1/8W	07716	CEATO
R902	R: 226Ω ½% 1/8W	07716	CEATO
R903	R: 71.5Ω ½% 1/8W	07716	CEATO
R904	R: 33.2Ω ½% 1/8W	07716	CEATO

PC Bd. E95357 Q-RMS Detector

Ref Desig.	Description	Manufacturer (FSCM Code #)	Part Number
C1001	C: 2μF 15V	13606	TE 1149
C1002	C: 0.001μF 1Kv	71590	DD 102
C1003	C: 4.7μF 25V	05397	K4R7W25K
C1004	C: 15μF 10V	05397	K15W10K
C1005, C1006	C: 10μF 20V	13606	150D
C1007, C1008	C: 10μF 15V	13606	TE 1155
C1009	C: 20μF 25V	09353	APD 045
C1010	C: 11-110pf trimmer	72982	557-09134E
C1011	C: 50μF 15V	13606	TE 1160
C1012	C: 10μF 15V	13606	TE 1155
C1013	C: 33pf 1Kv	71590	DD 330
C1014	C: 150pf 1Kv	71590	DD 151
C1015	Sel val		
R1001	R: 330K 10% $\frac{1}{4}$W	01121	RC07
R1002	R: 100K 10% $\frac{1}{2}$W	01121	RC07
R1003, R1004	R: 15K 10% $\frac{1}{4}$W	01121	RC07
R1005	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1006	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1007	R: 5.6K 10% $\frac{1}{4}$W	01121	RC07
R1008, R1009	R: 1.2K 10% $\frac{1}{4}$W	01121	RC07
R1010	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1011	R: 2.2K 10% $\frac{1}{4}$W	01121	RC07
R1012	R: 12K 10% $\frac{1}{4}$W	01121	RC07
R1013	R: 2.7K 10% $\frac{1}{4}$W	01121	RC07
R1014	R: 12K 10% $\frac{1}{4}$W	01121	RC07
R1015	Pot: 1K	71450	UPE200RE-1
R1016	R: 36K 5% $\frac{1}{4}$W	01121	RC07
R1017	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1018	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1019	R: 1.3K 1% 1/8W	07716	CEATO
R1020	R: 301Ω 1% 1/8W	07716	CEATO
R1021	R: Pot: 100Ω	71450	UPE200RE-1
R1022	R: 680Ω 10% $\frac{1}{4}$W	01121	RC07
R1023	R: 270Ω 10% $\frac{1}{4}$W	01121	RC07
R1024	R: 1.2K 10% $\frac{1}{4}$W	01121	RC07
R1025	Pot: 100Ω	71450	UPE200RE-1
R1026	R: 82Ω 10% $\frac{1}{4}$W	01121	RC07
R1027	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1029	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1030	Pot: 1K	71450	UPE200RE-1
R1031	R: 390Ω 10% $\frac{1}{4}$W	01121	RC07
R1032	R: 1.8K 10% $\frac{1}{4}$W	01121	RC07
R1033	R: 2.0K 1% 1/8W	07716	CEATO
R1034	R: 3.3K 10% $\frac{1}{4}$W	01121	RC07
Q1001	Transistors: NPN	15873	2N3903
Q1002 thru Q1005	Transistors: PNP	15873	2N3905
Q1006 thru Q1009	Transistors: NPN	15873	2N3903
CR1001	Diode	12065	1N4148

PC Bd. E95362 C MSG/CCITT

Ref Desig.	Description	Manufacturer (FSCM Code NO.)	Part Number
R1101	Pot: 10K	07716	500
R1102	R: sel val	01121	RC07
R1103	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1104	R: sel val	01121	RC07
R1105	R: 27K 10% $\frac{1}{4}$W	01121	RC07
R1106	R: 68K 10% $\frac{1}{4}$W	01121	RC07
R1107	R: 3.9K 10% $\frac{1}{4}$W	01121	RC07
R1108	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1109	R: 4.7K 10% $\frac{1}{4}$W	01121	RC07
R1110	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1111	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1112	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1113	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1114	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1115	R: 470Ω 10% $\frac{1}{4}$W	01121	RC07
R1116	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1117	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1118	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1119	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1120	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1121	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1122	R: 470Ω 10% $\frac{1}{4}$W	01121	RC07
R1123	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1124	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1125	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1126	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1127, R1128	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1129	R: 470Ω 10% $\frac{1}{4}$W	01121	RC07
R1130	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1131	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1132	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1133	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1134, R1135	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1136	R: 270Ω 10% $\frac{1}{4}$W	01121	RC07
R1137	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1138	R: 1.5K 10% $\frac{1}{4}$W	01121	RC07
R1139	R: 390Ω 10% $\frac{1}{4}$W	01121	RC07
R1140	R: 1K 10% $\frac{1}{4}$W	01121	RC07
Q1101 - 1106	Transistors: PNP	15873	2N3905
C1101	C: 0.22μF 50V	05397	KR22W50K
C1102	C: 0.1μF 50V	05397	KR1W50K
C1103	C: 0.0056μF 100V	13606	225PW
C1104	C: 1.0μF 35V	05397	K1W35K
C1105	C: 0.015μF 100V	13606	225PW
C1106	C: 22μF 6V	05397	K22W6K
C1107	C: 0.012μF 100V	13606	225PW
C1108	C: 0.056μF 100V	13606	225PW

PC Bd. E95362 C MSG/CCIT (cont)

Ref Desig.	Description	Manufacturer (FSCM Code #)	Part Number
C1109	C; 0.015μF 100V	13606	225PW
C1110	C: 22μF 6V	05397	K22W6K
C1111	C: 0.012μF 100V	13606	225PW
C1112	C: 0.056μF 100V	13606	225PW
C1113	C: 0.015μF 100V	13606	225PW
C1114	C: 22μF 6V	05397	K22W6K
C1115	C: 0.012μF 100V	13606	225PW
C1116	C: 0.056μF 100V	13606	225PW
C1117	C: 0.015μF 100V	13606	225PW
C1118	C: 22μF 6V	05397	K22W6K
C1119	C: 0.012μF 100V	13606	225PW
C1120	C: 100μF 12V	22650	16-375-100-12-8PA
C1121	C: 2.2μF 35V	05397	K2R2W35K

PC Bd. E95275 Inter. Amplifier

Q1201 thru 1203	Transistors: PNP	15873	2N3905
C1201	C: 4.7μF 25V	05397	K4R7W35K
C1202	not used		
C1203	C: 6.8μF 20V	05397	K6R8W20K
C1204	C: 15μF 10V	05397	K15W10K
C1205	C: 22μF 6V	05397	K22W6K
R1201	R: 2K pot	71450	UPE200RE-1
R1202	R: 150K 5% $\frac{1}{2}$W	01121	RC20
R1203	R: 301Ω 1% 1/8W	07716	CEATO
R1204, 1205	R: 33K 5% $\frac{1}{2}$W	01121	RC20
R1206	R: sel val		
R1207	R: 2.2K 5% $\frac{1}{2}$W	01121	RC20
R1208	R: 390Ω 10% $\frac{1}{2}$W	01121	RC20
R1209	R: 2.2K 5% $\frac{1}{2}$W	01121	RC20
R1210	R: 8.25K 1% 1/8W	07716	CEATO
R1211	not used		
R1212	R: 1K 10% $\frac{1}{2}$W	01121	RC20

PC Bd. E95312 -12V Regulator Board

Q1301 thru 1304	Transistors: PNP	17803	2N4356
CR1301	Diode	01295	1N2069
CR1302	Diode: zener	12065	1N762
C1301	C: 0.1μF 100V	13606	225PW
C1302	C: 250μF 25V		APD 126
C1303, 1304	C: 20μF 25V		APD 046
C1305	C: 15μF 10V	05397	K15W10K
R1301, 1302	R: 33K 5% $\frac{1}{2}$W	01121	RC20
R1303	R: 3.9K 5% $\frac{1}{2}$W	01121	RC20
R1304	R: 15K 5% $\frac{1}{2}$W	01121	RC20
R1305	R: 5K pot	71450	UPE200RE-1
R1306 thru 1308	R: 10K 10% $\frac{1}{2}$W	01121	RC20

PC Bd. E95315 -18V Regulator Board

Q1401	Transistor: NPN	49671	2N3054
Q1402	Transistor: PNP	17803	2N4356
CR1401 thru 1406	Diodes	01295	1N2069
CR1407	Diode: zener	15873	1N967
C1401, 1402	C: 470pf 1Kv	71590	DD 471
C1403	C: 100μF 50V	22650	MD-24-437-100-50
R1401	R: 4.7K 10% ½W	01121	RC20
L1401, 1402	Inductor: 100μh		9350-08
F1401	Fuse: 1/10 amp	75915	3AG-1/10SB

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
	S-1 Frequency Range		
S1	S: rotary 4dk, 8 pole 6 pos shorting	71590	1268-083
R6	R: 6.04 Meg 1%	03888	PME 65TO
R7	R: 619K 1% 1/8W	07716	CEATO
R8	R: 61.9K 1% 1/8W	07716	CEATO
R9	R: 6.19K 1% 1/8W	07716	CEATO
R10	R: 6.04 Meg 1%	03888	PME 65T0
R11	R: 619K 1% 1/8W	07716	CEATO
R12	R: 61.9K 1% 1/8W	07716	CEATO
R13	R: 6.19K 1% 1/8W	07716	CEATO
C9	Sel val		
	S-3 Fixed Frequency		
S3	S: rotary 4 dk, 4 pole, 12 pos positive shorting	71590	1268-084
R14	R: 18.7K 1% 1/8W	07716	CEATO
R15	R: 1.1 Meg 5% $\frac{1}{2}$W	01121	RC 20
R16	R: 13.7K $\frac{1}{2}$% 1/8W	07716	CEATO
R17	R: 11K $\frac{1}{2}$% 1/8W	07716	CEATO
R18	R: 6.81K $\frac{1}{4}$% 1/8W	07716	CEATO
R19	R: 5.49K $\frac{1}{2}$% 1/8W	07716	CEATO
R20	R: 3.48K 1% 1/8W	07716	CEATO
R20A	R: 240K 5% $\frac{1}{2}$W	01121	RC20
R21	R: 2.74K $\frac{1}{2}$% 1/8W	07716	CEATO
R22	R: 2.32K 1% 1/8W	07716	CEATO
R22A	R: 150K 5% $\frac{1}{2}$W	01121	RC20
R23	R: 2.21K 1% 1/8W	07716	CEATO
R23A	R: 330K 10% $\frac{1}{2}$W	01121	RC20
R24	R: 1.96K $\frac{1}{2}$% 1/8W	07716	CEATO
R25	R: 1.71K $\frac{1}{2}$% 1/8W	07716	CEATO
R26	R: 931Ω 1% 1/8W	07716	CEATO
R26A	R: 56K 10% $\frac{1}{2}$W	01121	RC20
R27	R: 18.7K 1% 1/8W	07716	CEATO
R28	R: 1.1 Meg 5% $\frac{1}{2}$W	01121	RC20
R29	R: 13.7K $\frac{1}{2}$% 1/8W	07716	CEATO
R30	R: 11K $\frac{1}{2}$% 1/8W	07716	CEATO
R31	R: 6.81K $\frac{1}{4}$% 1/8W	07716	CEATO
R32	R: 5.49K $\frac{1}{2}$% 1/8W	07716	CEATO
R33	R: 3.48K 1% 1/8W	07716	CEATO
R33A	R: 240K 5% $\frac{1}{2}$W	01121	RC20
R34	R: 2.74K $\frac{1}{2}$% 1/8W	07716	CEATO
R35	R: 2.32K 1% 1/8W	07716	CEATO
R35A	R: 150K 5% $\frac{1}{2}$W	01121	RC20
R36	R: 2.21K 1% 1/8W	07716	CEATO
R36A	R: 330K 10% $\frac{1}{2}$W	01121	RC20
R37	R: 1.96K $\frac{1}{2}$% 1/8W	07716	CEATO
R38	R: 1.71K $\frac{1}{2}$% 1/8W	07716	CEATO
R39	R: 931Ω 1% 1/8W	07716	CEATO
R39A	R: 56K 10% $\frac{1}{2}$W	01121	RC20

S-4 Send Level

S4	S: rotary, 4 dk 4 pole 12 pos positive shorting	71590	1268-084
R40	R: 146Ω ½% 1/8W	07716	CEATO
R41	R: 196Ω ½% 1/8W	07716	CEATO
R42	R: 69.2Ω ½% 1/8W	07716	CEATO
R43	R: 38.9Ω ½% 1/8W	07716	CEATO
R44	R: 49.9Ω ½% 1/8W	07716	CEATO
R45	R: 133.8Ω ½% 1/8W	07716	CEATO
R46	R: 122.5Ω ½% 1/8W	07716	CEATO
R47	R: 133.8Ω ½% 1/8W	07716	CEATO
R48	R: 91.75Ω ½% 1/8W	07716	CEATO
R49	R: 371.3Ω ½% 1/8W	07716	CEATO
R50	R: 91.7Ω ½% 1/8W	07716	CEATO
R51	R: 79.9Ω ½% 1/8W	07716	CEATO
R52	R: 1180Ω ½% 1/8W	07716	CEATO
R53	R: 79.9Ω ½% 1/8W	07716	CEATO

SEND section miscellaneous

C1A, C1B	C: 13.5-452.3pf	84411	25.2A
C2	C: 100μF 150V NP	13606	D 47141
	Spacers: 4-40 1 1/16" hex spacer	06540	8221-B-0440
R1	R: 2.5K pot	71590	B9-856
	¾" hex-standoff Male/female	06540	9741-A-0440
T1	Transformer	80223	A-20
T2	Transformer	06819	4008-01-0808
S2	S: toggle DP/DT	09353	7201
J1	Binding post: red insulated		5595-175-2
J2, J3	Binding post: black insulated		5595-175-0
TP1, TP2	Standoff-insulated		260-1
S5	S: rotary (SEND IMP) 6 dk 12 pole, 5 pos shorting	76854	A-1268-081

LINE section

C3	C: 0.05μF 200V	13606	2TM-S50
C4	C: 2μF 150V	13606	121P20591R5S4
C5	C: 10μF 50V	13606	TVA-1304
R3	R: 20K 5% ½W	01121	RC20
R4	R: 500Ω 5% 3W	13606	242E5015
L1, L2	Hold coils	06819	TN 1274
S6	S: toggle DP/DT	09353	7201
S7	S: key	82389	172N
S8, S9	S: key	82389	173P
J4	J: For 310 type plug	82389	5J-1192
J5	J: For 309 type plug	82389	5J-1490A
J6	J: For 310 type plug	82389	5J-1492
J7, J8	J: For 52A type plug	82389	5J-1194
J9	J: For 309 type plug	82389	5J-1490A
J10, J11	J: For 310 type plug	82389	5J-1492

S-14 REC IMP

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
S14	S: rotary 5 dk 10 pole, 5 pos shorting	71590	A-1268-082
R54, R55	R: 68.1Ω 1% 1/8W	07716	CEATO
R56, R57	R: 75Ω 1% 1/8W	07716	CEATO
R58, R59	R: 301Ω 1% 1/8W	07716	CEATO
R60, R61	R: 453Ω 1% 1/8W	07716	CEATO
T6	Transformer	06819	4009-010808

S-16 REC LEVEL

S16	S: rotary 6 dk 6 pole 15 pos non-shorting	76854	269130-EK8
R62, R63	R: 48.7K 1% 1/8W	07716	CEATO
R64	R: 3.83K 1% 1/8W	07716	CEATO
R65	R: 6.98K 1% 1/8W	07716	CEATO
R66	R: 3.83K 1% 1/8W	07716	CEATO
R67	R: 11K 1% 1/8W	07716	CEATO
R68	R: 3.83K 1% 1/8W	07716	CEATO
R69	R: 15K 1% 1/8W	07716	CEATO
R70	R: 3.83K 1% 1/8W	07716	CEATO
R71	R: 11K 1% 1/8W	07716	CEATO
R72	R: 3.83K 1% 1/8W	07716	CEATO
R73	R: 11K 1% 1/8W	07716	CEATO
R74	R: 3.83K 1% 1/8W	07716	CEATO
R75	R: 11K 1% 1/8W	07716	CEATO
R76	R: 3.83K 1% 1/8W	07716	CEATO
R77	R: 11K 1% 1/8W	07716	CEATO
C6, C7	C: 6.8pf 1Kv	71590	DD 6R8

RECEIVE section miscellaneous

C8	C: 50μF 75V NP	13606	D-27359
R5	R: 360Ω 10% ½W	01121	RC20
T4	Transformer	80223	A-20
J12	Binding post: uninsulated	83330	137-SP
J13	J: type 310 telephone	82389	5J-1329
J14	J: type 310 telephone	82389	5J-1192
J15, J16	Binding post: black insulated		5595-175-0
J17	Binding post: red insulated		5595-175-2
S10, S12	S: toggle 3P/DT	09353	7301
S11	S: toggle 4P/DT	09353	7401
S13	S: toggle SP/DT	09353	7101
S15	S: toggle DP/DT	09353	7201
S18/19	S: rotary (concentric snap)	76854	PA-620-046-0AA

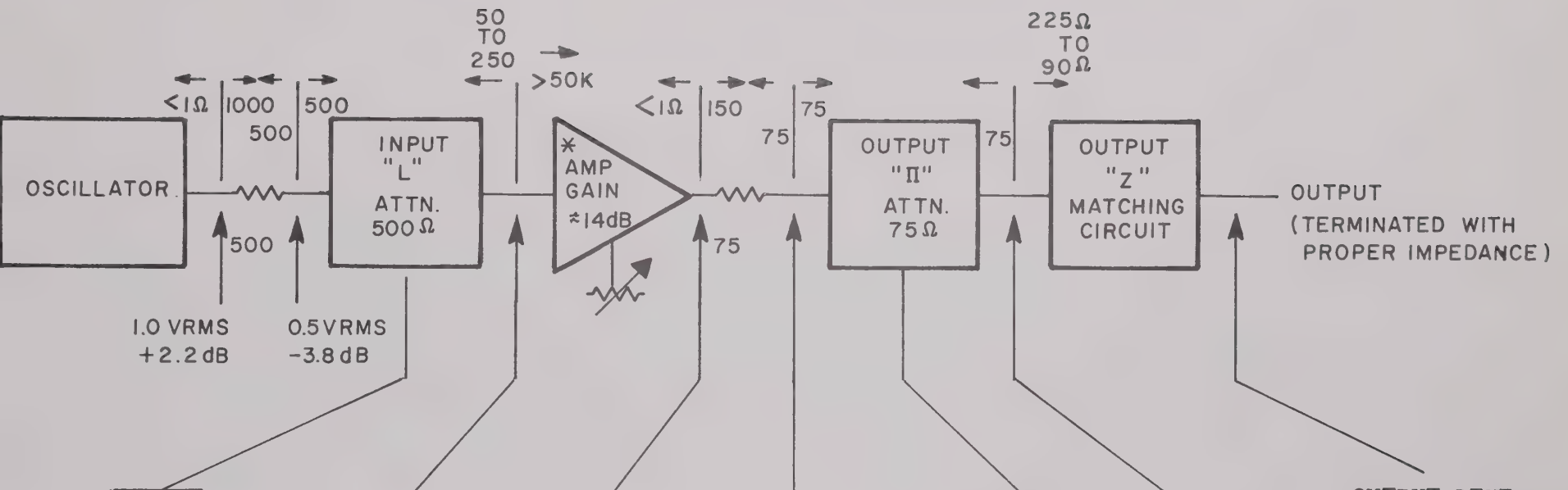
POWER section

T5	Transformer	Stancor*	P-8394
S17	S: toggle DP/3 position	09353	7203
J19	AC receptacle	82389	AC3G
J18	CO Battery jack	82389	L112B

SECTION 7

SCHEMATIC DIAGRAMS

7.1 INTRODUCTION. The following pages contain the schematic diagrams for the Model TTS 4C.

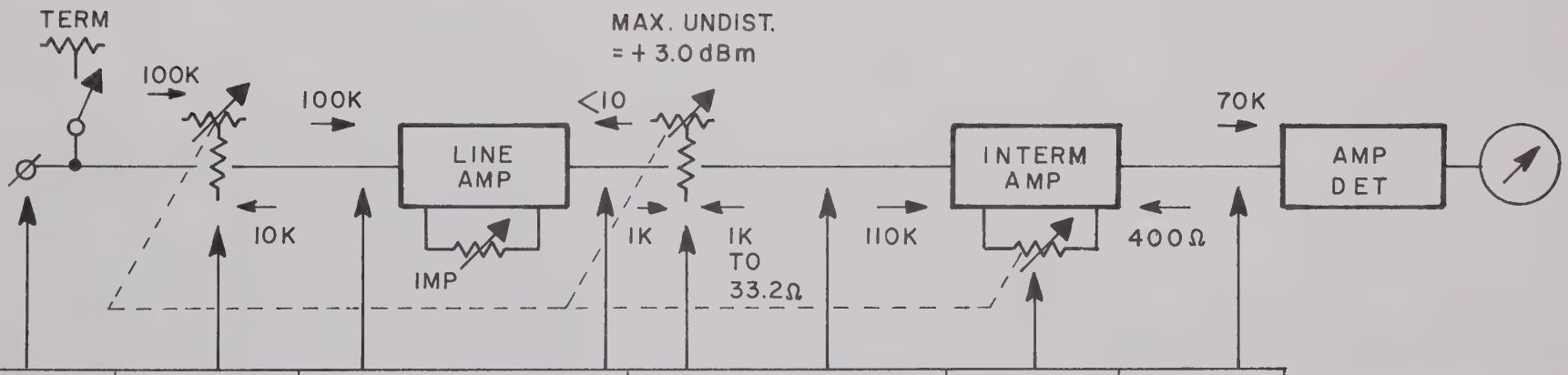


ATTN				ATTN		OUTPUT LEVEL SWITCH POSITION
0 dB	- 3.8 dB	+10.2 dB	+ 4.2 dB	0 dB	+ 4.2 dB	+10 dBm
3 dB	- 6.8 dB	+ 7.2 dB	+ 1.2 dB	0 dB	+ 1.2 dB	+ 7 dBm
10 dB	-13.8 dB	+ 0.2 dB	- 5.8 dB	0 dB	- 5.8 dB	0 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	0 dB	-10.8 dB	- 5 dBm
20 dB	-23.8 dB	- 9.8 dB	-15.8 dB	0 dB	-15.8 dB	-10 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	11 dB	-21.8 dB	-16 dBm
10 dB	-13.8 dB	+ 0.2 dB	- 5.8 dB	20 dB	-25.8 dB	-20 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	20 dB	-30.8 dB	-25 dBm
20 dB	-23.8 dB	- 9.8 dB	-15.8 dB	20 dB	-35.8 dB	-30 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	30 dB	-40.8 dB	-35 dBm
20 dB	-23.8 dB	- 9.8 dB	-15.8 dB	30 dB	-45.8 dB	-40 dBm

*With vernier set for +10 dBm.

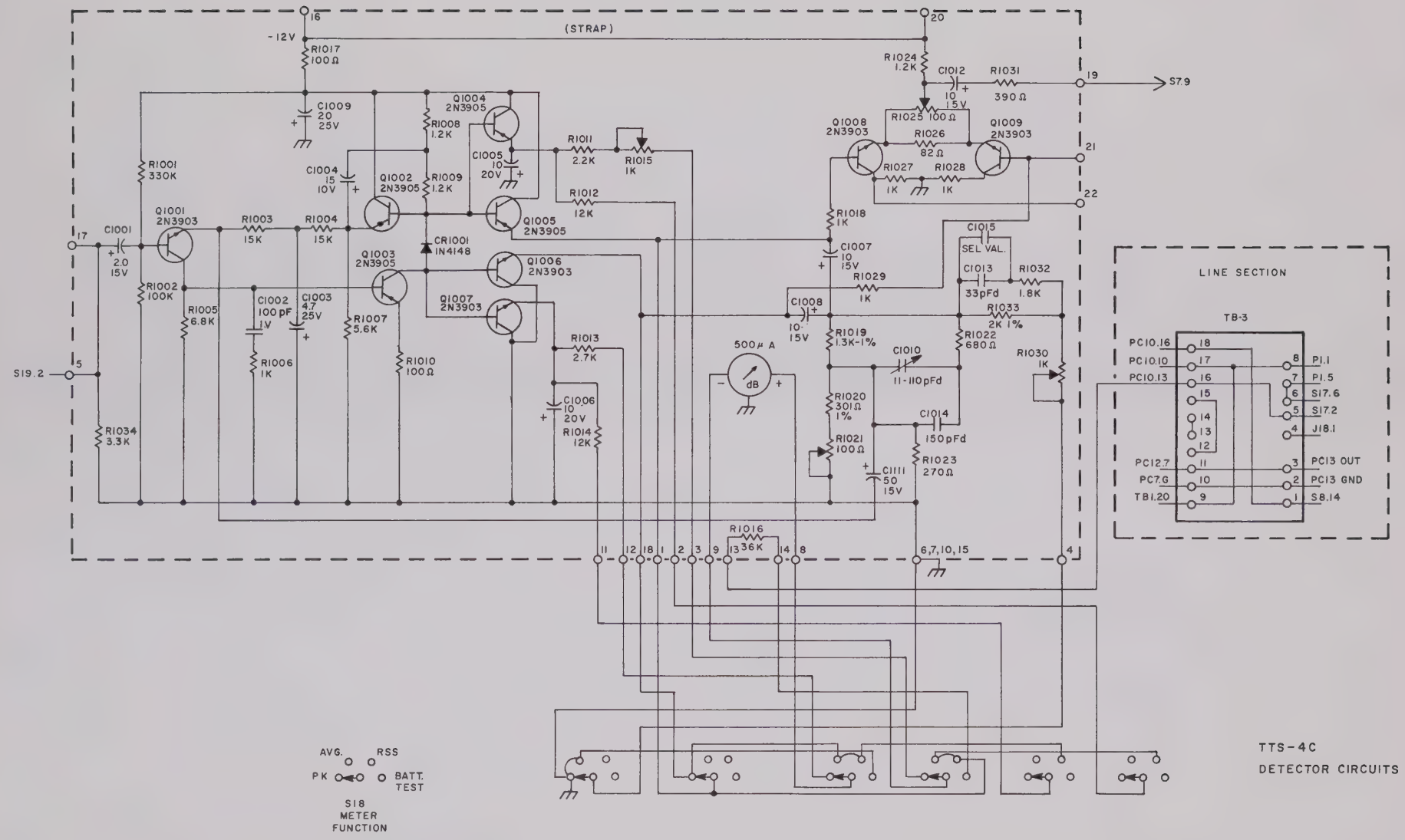
NOTE: dB values are relative to 600 ohms.
dBm values are relative to 75, 135, 150, 600 or 900 ohms.

SEND SECTION LEVEL DIAGRAM

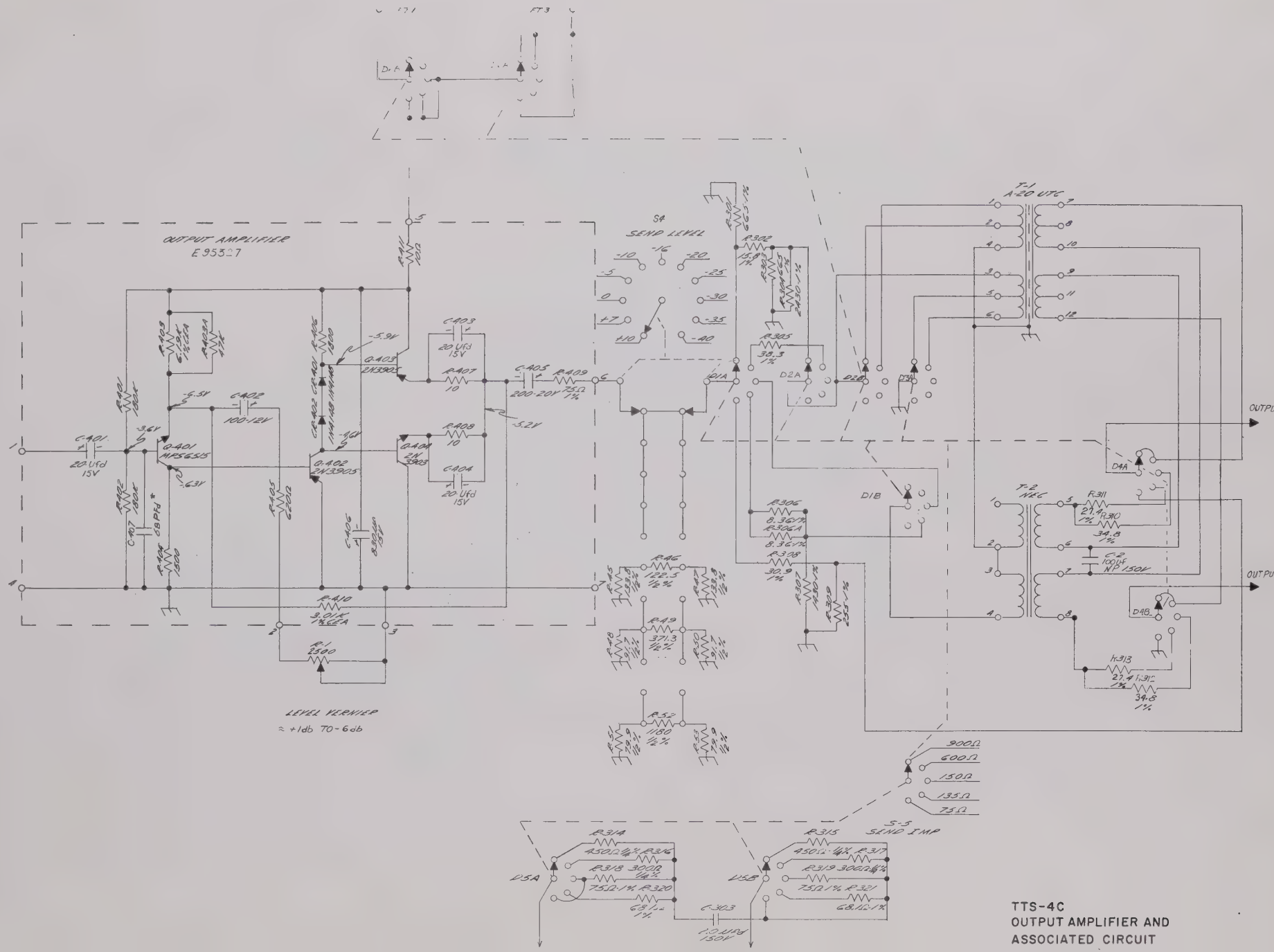


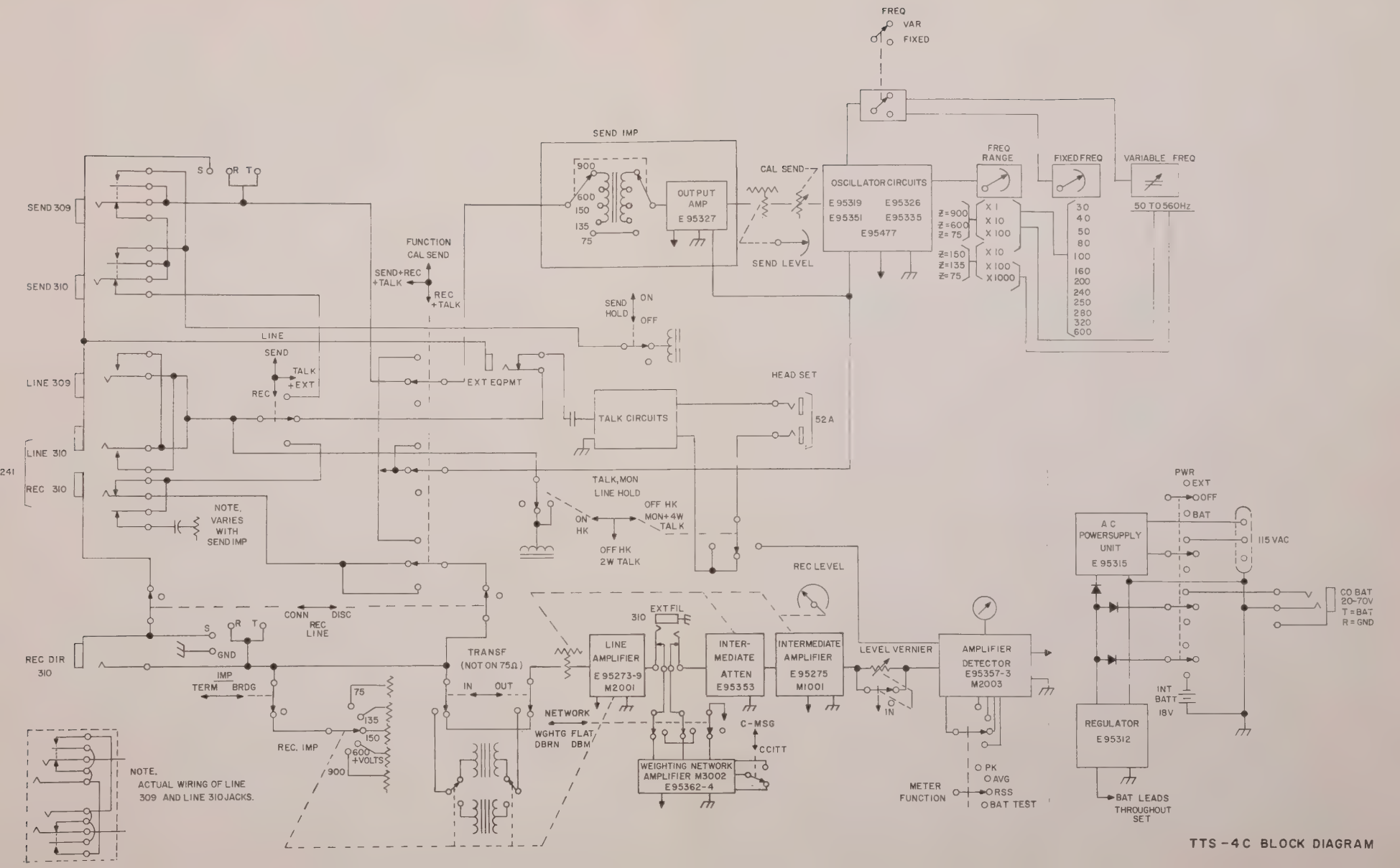
POS.	LINE	LINE ATT.	10 dB LINE AMP INPUT	10 dB LINE AMP OUTPUT	INTERN ATT. ATT.	INTERN ATT. OUTPUT	INTERN AMP. GAIN	AMP. DET. INPUT
1	+10	30	-20	-10	30	-40	20	-20
2	+ 7	30	-23	-13	30	-43	23	-20
3	0	30	-30	-20	20	-40	20	-20
4	- 5	30	-35	-25	20	-45	25	-20
5	-10	30	-40	-30	10	-40	20	-20
6	-16	30	-46	-36	10	-46	26	-20
7	-20	0	-20	-10	30	-40	20	-20
8	-25	0	-25	-15	30	-45	25	-20
9	-30	0	-30	-20	20	-40	20	-20
10	-35	0	-35	-25	20	-45	25	-20
11	-40	0	-40	-30	10	-40	20	-20
12	-45	0	-45	-35	10	-45	25	-20
13	-50	0	-50	-40	0	-40	20	-20
14	-55	0	-55	-45	0	-45	25	-20
15	-60	0	-60	-50	0	-50	30	-20

RECEIVE SECTION LEVEL DIAGRAM

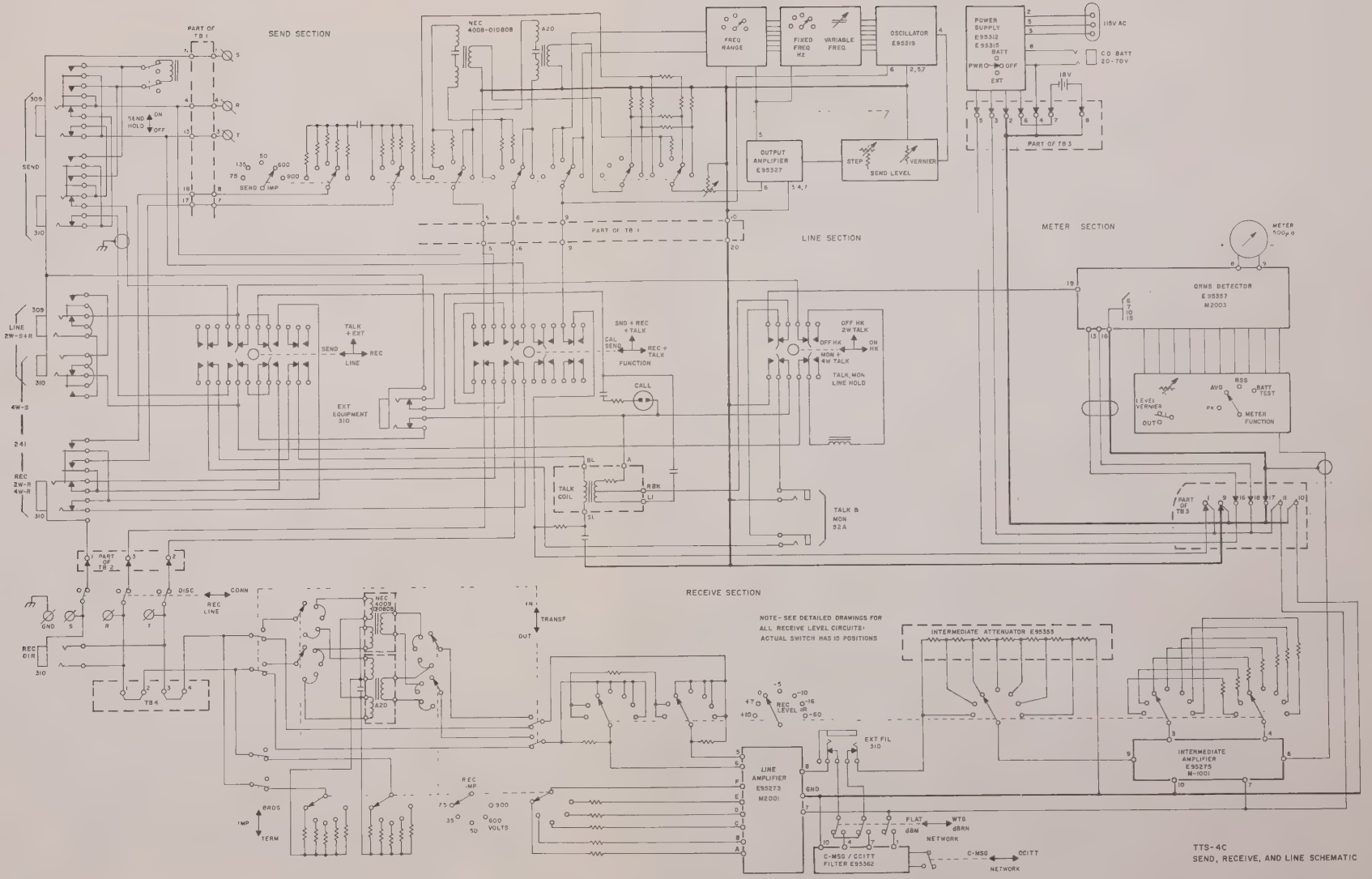


TTS-4C
DETECTOR CIRCUITS

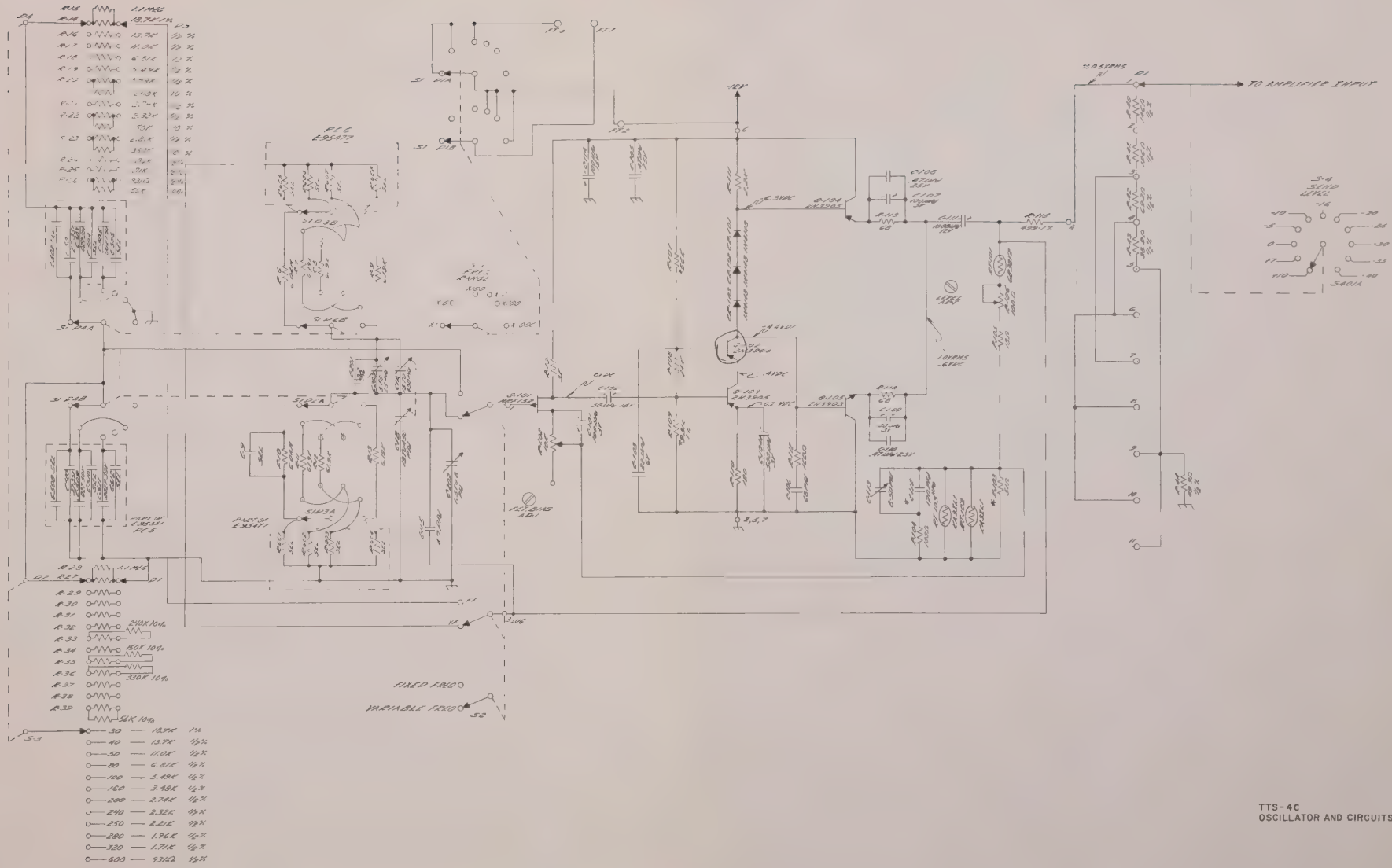

OUTPUT AMPLIFIER
E95327
LEVEL VERNIER
≈ +1db TO -6db
S4
SEND LEVEL
T-1
A-20 U/C
T-2
N12C
OUTPUT
OUTPUT
900Ω
600Ω
150Ω
135Ω
75Ω
S-5
SEND IMP
TTS-4C
OUTPUT AMPLIFIER AND
ASSOCIATED CIRCUIT



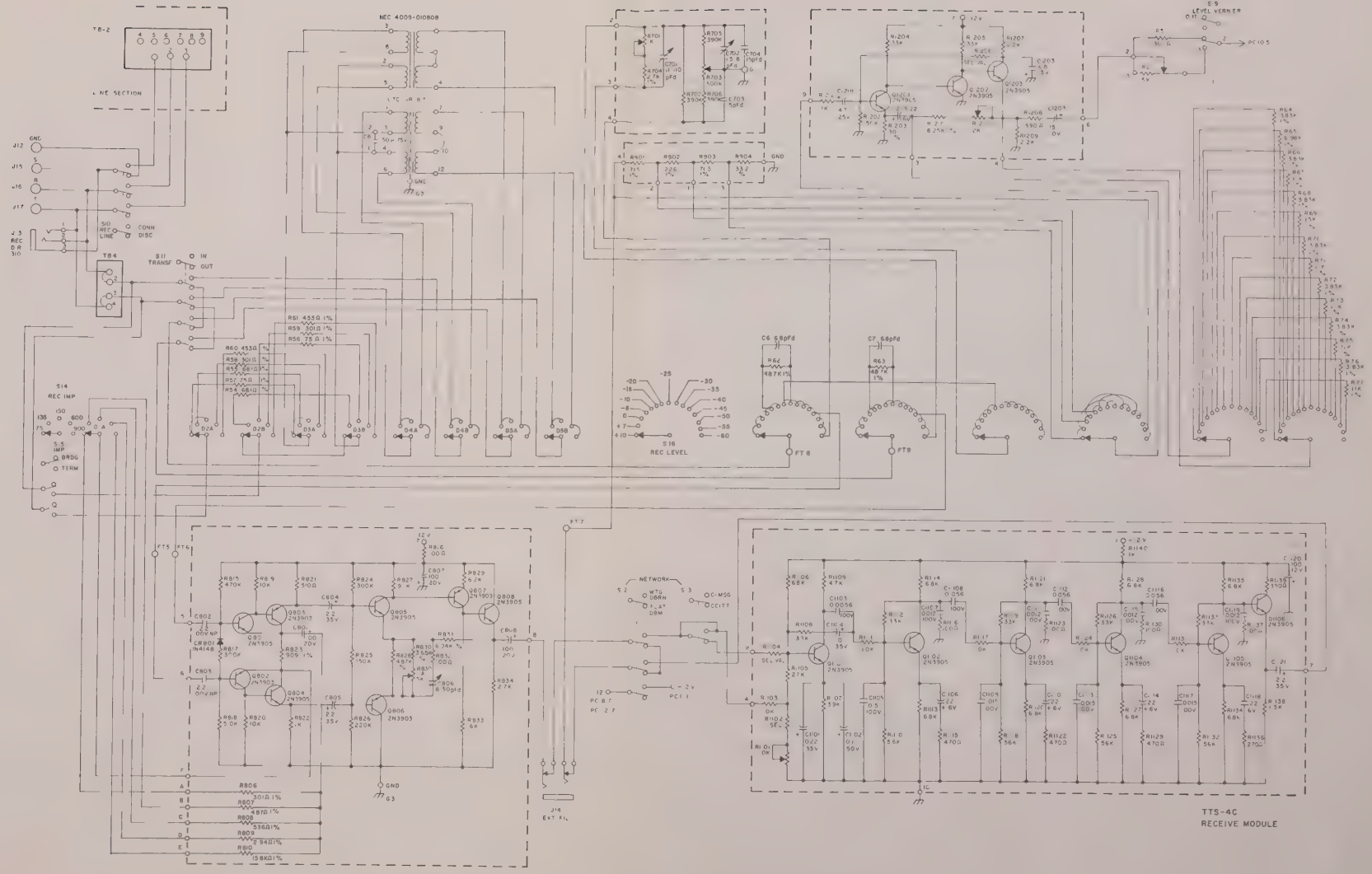
TTS-4C BLOCK DIAGRAM

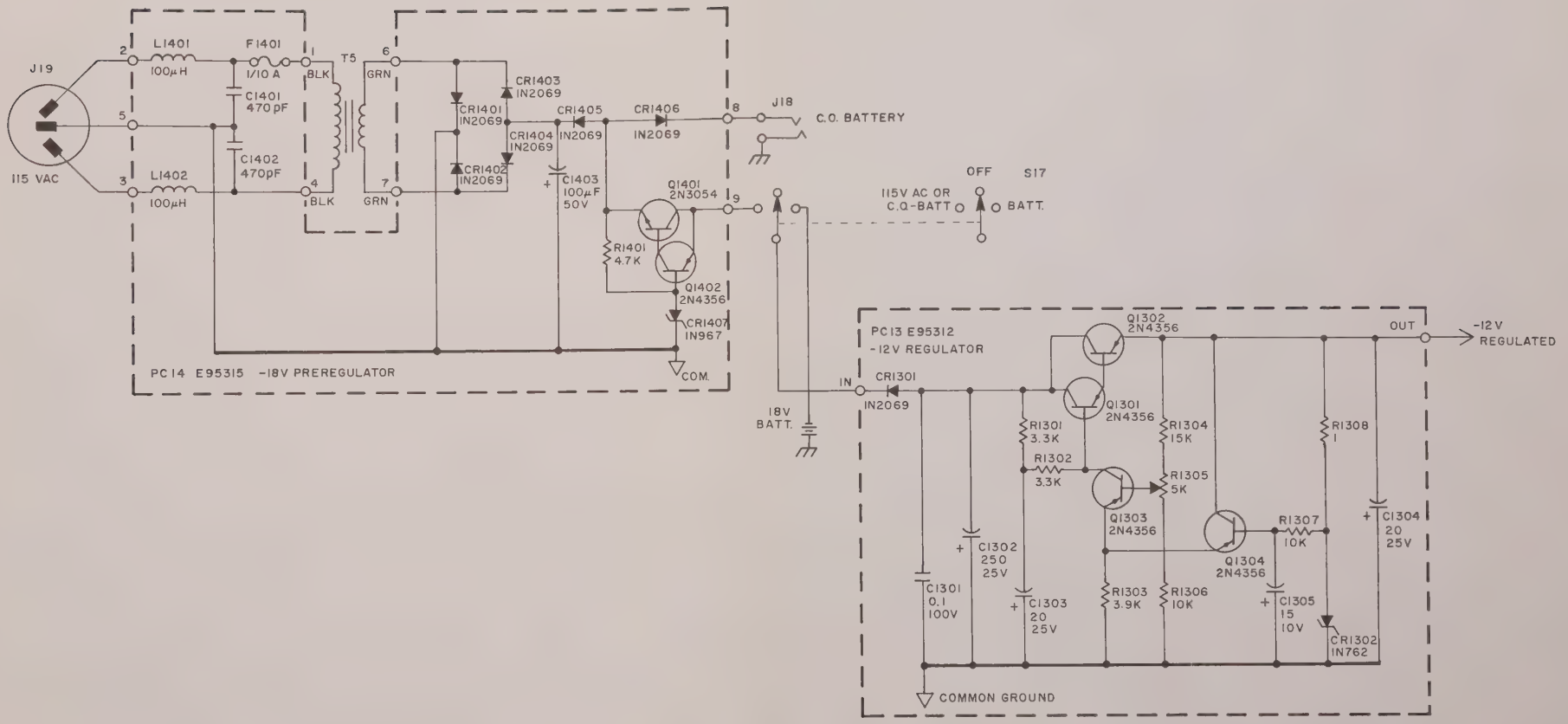


TTS-4C
SEND, RECEIVE, AND LINE SCHEMATIC



TTS-4C
OSCILLATOR AND CIRCUITS


TTS-4C
RECEIVE MODULE



TTS-4C
POWER SUPPLY

APPENDIX 1

GENERAL OPERATING INSTRUCTIONS

A1.1 OPERATION

A1.2 Open the Cover. It may be removed by sliding it off its hinges.

A1.3 Select the Source of Power. If it is desired to operate on ac, insert the special cord which is provided into the receptacle marked AC on the Set and the other side into an ac outlet. Move the PWR switch to the EXT position.

If it is desired to operate from a central office battery, FIRST insert a 310 ended cord into the set and then connect the other side to the source of power. Move the PWR switch to the EXT position. Any central office battery with a voltage between 20 and 70 volts may be used. When disconnecting the set, FIRST remove the cord from the source of power and then remove it from the set.

CAUTION: DO NOT CHANGE THE SEQUENCE OF CONNECTING OR DISCONNECTING THE DC POWER CORD.

If it is desired to operate from internal batteries, move the PWR switch to the BAT position. Check the condition of the internal batteries by moving the METER FUNCTION switch to the BAT TEST position. If the meter reads below the green arc, replace batteries.

A1.4 Select the METER FUNCTION. To do this, turn the METER FUNCTION switch to the desired position. Unless otherwise specified in the test procedures, use the average (AVG) position. Make sure that the LEVEL VERNIER control is in the OUT position by turning it fully clockwise until a click is felt.

A1.5 Calibrate the Set.

To calibrate the set, proceed as follows:

A. Receive Section

1. Make sure that the LEVEL VERNIER control is in the OUT position by turning it fully clockwise until it clicks.

2. Set the METER FUNCTION switch in the average (AVG) position.

3. Set the REC LEVEL switch in the 0 dBm (CAL) position.

4. Turn the REC IMP switch to 600Ω. Move the following switches to the positions indicated.

5. REC LINE to connect (CONN).

6. TRANSF to IN.

7. NETWORK (left switch) to FLAT DBM.

8. NETWORK (right switch) to C MSG position.

9. IMP to TERM.

B. Line Section

1. Move the FUNCTION switch to CAL SEND position.

C. Send Section

1. Set the frequency selection controls to produce a 1000 Hz signal.

2. Set the SEND LEVEL control to 0 dBm (CAL).

3. Set the SEND IMP switch to 600Ω.

4. Now adjust the SEND LEVEL vernier to produce a 0 dBm reading on the meter and lock the control in this position.

D. Receive Section.

If the receive section is to be used in a circuit with a different impedance than the send section, move the REC IMP switch to that position. The gain of the receive section is automatically changed by the proper amount when another receive impedance is selected; therefore, the receive section remains calibrated at any setting of the REC IMP switch.

E. Line Section.

Return the FUNCTION switch to the SND+REC+TALK position; the set is now ready for use.

F. Notes on Special Operations.

1. If it is desired to calibrate the send level at a different send frequency than 1000 Hz, insert this frequency in step C1.

2. If the send section is to operate at another impedance than 600Ω, then change Steps A4 and C3 from 600Ω to the desired impedance in the calibration procedure.

3. To send any level which is not present on the SEND LEVEL switch, change steps A3 and C2 from "set the REC LEVEL switch to the 0 dBm (CAL) position" to "set the level switch to a position which is within ±3 dB of the desired level"and change step C4 to: "Produce the desired level reading" on the meter.

CAUTION: IN THIS CONDITION, THE LEVELS MARKED ON THE SEND LEVEL SELECTOR SWITCH ARE INCORRECT AND SHOULD NOT BE USED.

4. To measure deviations from a predetermined receive level, which is not available on the REC LEVEL switch, set the send section to this level as described above and then adjust the receive LEVEL VERNIER control until a 0 dB reading is observed. NOTE: it may be necessary to turn the REC LEVEL control one step up or down.

CAUTION: THIS LEAVES BOTH THE SEND AND THE RECEIVE LEVEL IN AN "UNCALIBRATED" CONDITION: I.E., THE MARKINGS ON THE LEVEL SELECTOR SWITCHES ARE NOW INCORRECT AND SHOULD NOT BE USED.

A1.6 Connect the Set to the Circuit.

It is assumed that the set has been calibrated for normal operation by following steps A through E above. To connect the set to the circuit under test, proceed as follows:

A. Normal Operation.

1. Two-wire Circuits.

Connect the circuit under test to the LINE jacks, using either a 309 or 310 equipped cord and connect a 52A or equivalent headset to the TALK and MON jacks. Dialing on the line circuits can be performed in one of two ways.

a. If the line has been connected to the 310 line jack, an external dial may be inserted in series with the test set by connecting it to the 309 line jack. Similarly, if the line is connected to a 309 jack, an external dial may be connected in the 310 jack.

b. To use the dial circuit, which is provided in the cover of the TTS 4C, the line is connected to the terminals or jack marked LINE in the cover and the jack marked TTS 4C TEST SET (310) is connected by means of a patch cord to one of the LINE jacks of the TTS 4C. In this case, a short is applied across the circuit when the dial is in the "off normal" position. In addition, the switch should be in the DIAL+TEST SET (ON) position. When this switch is in the ON HOOK (OFF) position, it can connect a ringer, which can be mounted in the cover.

By means of the TALK-MON-LINE HOLD switch, the test set may be placed in an on hook or an off hook condition. In either condition, the SEND TALK and RECEIVE functions can be performed. The receive signal may be monitored by moving the TALK-MON-LINE-HOLD switch to the MON+4W TALK position; in this case the REC LEVEL switch should be turned to obtain a comfortable level in the receiver.

2. Four-Wire Circuits.

Connect the 310 LINE jack which is marked 2W-S+R, 4W-S to the send side of the circuit under test and the REC jack which is marked 2W-R, 4W-R to the receive side; connect a 52A headset or equivalent to the TALK + MON jack. The LINE switch now permits selection of the SND, TALK and REC functions. The TALK & MON switch should be moved to the MON +4W TALK position. In this case, the headset receiver is connected to the monitor output of the RECEIVE section. Therefore the REC LEVEL control must be turned to obtain the desired level. In the REC position, a termination is connected to the SEND circuit. The setting of the SEND IMP switch determines the value of this termination which has a 2.0 mf condenser in series with it. For further details, see the Description section.

B. Special Operations.

1. To obtain a precision termination, insert a dummy plug in the REC jack and the circuit to be terminated in the LINE 310 (2W-S+R, 4W-S) jack and turn the SEND IMP switch to the desired impedance.

DO NOT USE ON 75Ω.

2. To use the receive section separately and to disconnect it from all the wiring in the line section, move the REC LINE switch to the DISC position and connect to the REC DIR jack or the R+T terminals. Note that the S terminal is connected to the sleeve of the REC DIR jack. A transformer can be inserted in this application by using the TRANSF switch. In this application, no hold coil is provided.

3. To use the SEND section separately, calibrate it in the manner described above and insert a 310 or 309 cord into the SEND jacks. This automatically disconnects the circuits from the LINE circuits and connects a separate hold coil to the SEND section under the control of the SEND HOLD switch. To use the T+R terminals, a dummy plug must be inserted in one of the SEND jacks.

4. To measure transmission losses of any device which requires a dc closed loop at either or both sides, use the SEND section separately as described in step 3 above and connect the receive side of the device under test to the LINE jacks. In this application, move the LINE switch to the REC position and make sure that the REC LINE switch is in the CONN position. This method may be used to test cord circuits or the transmission through a complete central office.

5. To use the LINE section when the SEND and RECEIVE jacks are being used separately, no special provisions are required beyond connecting a 52A or equivalent headset to the TALK and MON jacks.

6. For further details about the special operations, consult the General Description section.

A1.7 Terminate Tests.

Move the PWR switch to the OFF position. If the set is to be moved to another location, remove all cords and the headset. Reattach the cover if it was disconnected and close it. When disconnecting the set, first remove the cord from the source of power and then remove it from the set.

CAUTION: DO NOT CHANGE THE SEQUENCE OF CONNECTING OR DISCONNECTING THE DC POWER CORD.

A1.8 Noise to Ground Measurements.

The cover contains circuits which provide measurements of Noise to Ground. To make these measurements, the line is connected to the LINE jacks (309 or 310) or the T and R binding post and a ground is connected to the ground terminal in the cover. This connects the signal to be measured to the input of the 40 dB Noise to Ground attenuator.

Next, connect a cord from the Noise to Ground jack (310), the output of the 40 dB noise to ground attenuator, to the line jacks or the T+R binding post of the Receive Section.

TTS 4C TTS 4CR CALIBRATION PROCEDURE

RECEIVE SECTION

4.1 CALIBRATION

This unit has been carefully calibrated and tested before shipment and should not need recalibration except in cases of age or misuse. If recalibration is required, the following steps should be taken using the recommended equipment shown in Table 4-1.

4.2 Table 4-2 represents a brief description on location of all calibration adjustment potentiometers and trimmer capacitors.

TABLE 4-1

	Description	Manufacturer and Model
1.	A C Voltmeter	H.P. 400FL or equivalent.
2.	Signal Generator - 100 Hz to 1 MHz capability normally 0 dBm output (75 and 600 ohms output impedance).	H.P. 652A or equivalent.
3.	High frequency oscilloscope	Tektronix 535 or equivalent.
4.	Attenuation Network	Daven Type VT795G or equivalent.
5.	Multimeter	Triplett Model 630NA or equivalent.
6.	Distortion Analyzer	H.P. Distortion Analyzer 333A or equivalent.

TABLE 4-2

Location	Ref. Design.	Purpose
Board #8 Line Amplifier	R830A	Adjust for approximately 10 dB of gain of the LINE Amplifier.
	C806	Adjust for an optimum frequency response for the LINE Amplifier at 1 MHz.
Board #7 40 dB Attenuation and freq. adjust.	R701	Adjust for 30 dB of attenuation at 1 kHz.
	R703	Adjust for input balance at 1 kHz.
	C701	Adjust for high frequency, 30 dB attenuation.
	C702	Adjust for input balance at 100 kHz.

Location	Ref. Design.	Purpose
Board #12 20-30 dB amp.	R1201	Adjust for approximately 20 dB of gain of the 20-30 dB amplifier.
Board #10 Q-RMS Detector	R1015	With an input of 0 dBm at 1 kHz, adjust for a 0 dBm meter output (M-1) with the METER FUNCTION switch (S-18) in PK position.
	R1021	With an input of 0 dBm at 1 kHz, adjust for a 0 dBm meter output (M-1) with the METER FUNCTION switch (S-18) in RSS position.
	R1030	With an input of 0 dB at 1 kHz, adjust for a 0 dBm meter output (M1) with the METER FUNCTION switch (S-18) in AVG position.
	C1010	Adjust for a 0 dBm meter output (M1) with an output of 0 dBm at 1 MHz with the METER FUNCTION switch (S-18) in the RSS position.

4.4 Set the front panel controls on the TTS 4C as follows:

Control	Setting
PWR switch	ON
METER FUNCTION switch	RSS
VERNIER OUT	DETENT position
REC LEVEL switch	-20 dBm
REC IMP switch	600 ohms
IMP switch	BRDG
NETWORK switch	FLAT DBM
TRANSF switch	OUT
REC LINE switch	DISC

4.5 LOW FREQUENCY (1 KHZ)

4.6 30 dB ATTENUATOR and FREQ adj.

Monitor the output (pin 8) of the line amplifier (Board #8 95273) with an AC voltmeter and adjust the input level at 1 kHz (600 ohms) for an output level of the line amplifier of -10 dBm. Switch the REC LEVEL switch (S-16) to the -10 dBm position. The output of the line amplifier should drop to a level of approximately -40 dBm. Adjust potentiometer R701 on the 30 dB attenuator board (Board #7 95360) for a drop of 30 dBm. Still

monitoring the output of the line amplifier with an AC voltmeter, reverse the polarity of the input signal to the set without changing any other controls. Adjust potentiometer R703 on the 30 dB Attenuator board until no change in the level is appreciably noticed with a reversal of the input signals polarity. Interaction between these two adjustments does occur and a readjustment of both may be required.

4.7 20-30 dB AMPLIFIER

Monitor the output (pin 6) of the 20-30 dB AMPLIFIER (Board #12 95275) with an AC voltmeter. Set the VERNIER OUT in the detented position and adjust the input signal for -50 dBm. Set the AC voltmeter for -30 dB range and adjust the input signal for a zero (0) level on the AC voltmeter. Switch the AC voltmeter to -20 dBm range and the REC LEVEL to -60 dB. Adjust potentiometer R1201 on the 20-30 dB AMPLIFIER (Board #12 95275) for a -20 dBm reading on the AC voltmeter.

4.8 Q-RMS DETECTOR

Set the front panel controls on the TTS 4C as follows, leaving all other controls in their initial settings.

Control	Setting
REC LEVEL switch	0 dBm
IMP switch	TERM

Monitor the input level to the test set using the AC voltmeter and adjust the oscillator for a 0 dBm reading at 1 kHz. Adjust potentiometers R1015, R1021 and R1030, located on the Q-RMS board (Board #10 95357) for an approximate mechanical mid-range setting. Next adjust R830A, located on the line amplifier board (Board #8 95273) for an approximate 0 dBm reading on the meter (M1). Adjust potentiometer R1021 for a 0 dBm reading on the meter. Switch the METER FUNCTION switch (S18) to the AVG position and adjust R1030 for a 0 dBm indication on the meter. Switch the METER FUNCTION switch (S18) to the PK position and adjust R1015 for a 0 dBm reading on the meter. Switching the METER FUNCTION switch should keep a constant reading of 0 dBm on the output meter with an input of 0 dBm to the test set.

4.9 REC LEVEL Switch (S16)

Tracking at 1 kHz of the REC LEVEL switch should be ± 0.15 dB from +20 dBm to -55 dBm setting, and ± 0.2 dB for the -60 dBm setting. Some adjustment of R701, located on the 30 dB ATTENUATOR board (Board #7 95360) may be required for this degree of accuracy.

4.10 HIGH FREQUENCY (100 kHz to 1 MHz)

Set the front panel controls of the TTS 4C as follows:

Control	Setting
PWR switch	ON
METER FUNCTION switch	RSS
VERNIER OUT	OUT position
REC LEVEL switch	-20 dBm
REC IMP switch	75 ohms
IMP switch	TERM
NETWORK switch	FLAT dBm
TRANSF switch	OUT
REC LINE switch	DISC

4.11 LINE AMPLIFIER

Monitoring the output of the line amplifier, pin 8, with an AC voltmeter and using 1 kHz (75 ohms) as a reference, set the oscillator for 100 kHz (75 ohms) at -20 dBm and increase to 1 MHz while noting for any peaking of the output signal of the balanced amplifier. Adjust trimmer capacitor C806, located on the line amplifier board (Board #8 95273) so that there is a rising response curve at 1 MHz. Readjust the output level of the oscillator for a 0 dB meter reading at 1 kHz and adjust C1010 located on the Q-RMS detector board (Board #10 95357) for a 0 dB indication on the meter.

4.12 30 dB ATTENUATOR

Set the REC LEVEL switch (S16) in the -10 dBm position and after setting the level of the oscillator for 0 dB meter reading at 1 kHz (75 ohms) increase the oscillator frequency to 1 MHz and adjust C701 located on the 30 dB attenuator board (Board #7 95360) for a 0 dB meter reading.

4.13 BALANCE

Set the REC LEVEL switch (S16) to the -10 dB position and set the oscillator at 100 kHz for a 0 dB meter reading. Reverse the polarity of the input and adjust the trimmer capacitor C702 located on the 30 dB attenuator board so that no appreciable level change is noted with repeated reversal of the input signal polarity.

4.14 If any different input levels are wished to be used, refer to the RECEIVE SECTION LEVEL DIAGRAM in section 7 of the manual for the appropriate intermediate signal levels or for tracing an input signal through the circuitry. If any difficulties arise that cannot be rectified by this calibration procedure it is highly recommended that any maintenance be accomplished at our factory.

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TTS 4C TTS 4CR CALIBRATION PROCEDURE

SEND SECTION

4.14 CALIBRATION:

Set the front panel controls of the TTS 4C as follows:

Control	Setting
PWR switch	ON
FREQ RANGE switch	X10 FIXED + VAR
FREQ	FIXED
FIXED FREQ Hz	100
SEND LEVEL	0 (CAL)
SEND IMP	600

4.15 OSCILLATOR BOARD

Monitor the output (pin 6) of the OUTPUT AMPLIFIER (Board #4 95327) with a Distortion Analyzer and a High Frequency Oscilloscope. Observe the output waveform and output level, if no signal exists, slowly adjust potentiometer R102 on the oscillator board (Board #1 95319) clockwise until a sine wave free of visual distortion is observed. Monitor the output (pin 4) of the oscillator board (Board #1 95319) with an AC voltmeter and adjust potentiometer R106 on the oscillator board for an output level of .5 VRMS. The distortion of the output of the output amplifier (pin 6) should be less than .5%. Readjustment of these two potentiometers will reduce the distortion.

4.16 If this calibration procedure does not correct any fault in the circuitry, along with the SEND SECTION LEVEL DIAGRAM in section 7, it is highly suggested that the unit be sent back to our factory for maintenance.

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TTS 4C TTS 4CR CALIBRATION PROCEDURE

SEND SECTION

4.14 CALIBRATION:

Set the front panel controls of the TTS 4C as follows:

Control	Setting
PWR switch	ON
FREQ RANGE switch	X10 FIXED + VAR
FREQ	FIXED
FIXED FREQ Hz	100
SEND LEVEL	0 (CAL)
SEND IMP	600

4.15 OSCILLATOR BOARD

Monitor the output (pin 6) of the OUTPUT AMPLIFIER (Board #4 95327) with a Distortion Analyzer and a High Frequency Oscilloscope. Observe the output waveform and output level, if no signal exists, slowly adjust potentiometer R102 on the oscillator board (Board #1 95319) clockwise until a sine wave free of visual distortion is observed. Monitor the output (pin 4) of the oscillator board (Board #1 95319) with an AC voltmeter and adjust potentiometer R106 on the oscillator board for an output level of .5 VRMS. The distortion of the output of the output amplifier (pin 6) should be less than .5%. Readjustment of these two potentiometers will reduce the distortion.

4.16 If this calibration procedure does not correct any fault in the circuitry, along with the SEND SECTION LEVEL DIAGRAM in section 7, it is highly suggested that the unit be sent back to our factory for maintenance.

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OPERATING ADDENDUM

The portable version of this instrument has been calibrated with the meter in the horizontal position and the rack-mounted version with the meter in the vertical position. To obtain the specified accuracy, the instrument must be operated in the same position in which it was calibrated. If it is desired to operate the instrument in another position, the instrument must be recalibrated while the meter is in the desired position.

MP MASTER
MA32767